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FOR THE

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BEING PART OF

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COMMUNICATED TO THE

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AT THE

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C. B. COMSTOCK, Lieut. Col. of Engineers, Bvt. Brig. Gen. U. S. A. (*president* from April 10, 1888),
CHARLES R. SUTER, Lieut. Col. of Engineers, U. S. A.,
O. H. ERNST, Major of Engineers, U. S. A. (from May 15, 1888),
Mr. HENRY MITCHELL, U. S. Coast and Geodetic Survey,
Mr. B. M. HARROD, Civil Engineer,
Mr. S. W. FERGUSON, Civil Engineer,
Mr. ROBERT S. TAYLOR,
Commissioners.

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ALEX. MACKENZIE, Major of Engineers, U. S. A.,
O. H. ERNST, Major of Engineers, U. S. A.,
Mr. G. C. BROADHEAD,
Mr. WM. J. BROATCH,
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UNITED STATES ARMY.

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REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS—IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS, AND OF GASCONADE RIVER, MISSOURI.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Removing snags and wrecks from the Mississippi and Missouri Rivers.
2. Mississippi River between the Ohio and Illinois Rivers.
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5. Mississippi River, at Rush Island Bend and Ivy Landing, Illinois.
6. Kaskaskia River, from New Athens to its mouth.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., July 9, 1888.

SIR: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1888, for the works under my charge.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

W 1.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS.

MISSISSIPPI RIVER.

The work for the fiscal year consisted in the removal of snags and leaning trees between the mouth of Missouri River and Vicksburg, Miss. Owing to the small amount of funds available for this work but one snag-boat, the *H. G. Wright*, was placed in commission.

The *Wright* began work on August 6, and continued at work until October 19, when she was called in and laid up at Bushberg, Mo., as the funds on hand would not warrant any further expenditure.

The work accomplished in the Mississippi River was as follows:

Name of snag-boat.	Snags pulled.		Trees cut.	Miles run.
	Number.	Weight.		
H. G. Wright	798	15,943	348	1,792

The work accomplished by the snag-boats is of great benefit to the navigation of the river. Formerly the wreck of steam-boats by running on snags was a very frequent occurrence. Since the snag-boats have been at work it is almost an unheard-of occurrence.

The annual changes taking place in the channel of the river cause the continual appearance of new snags, either by the scouring out of old "rack-heaps" in the bottom, or the caving in of timber along the banks, and a constant and continual vigilance is required to keep the channel in a safe condition. However opinions may differ as to the utility of permanent improvements on rivers like the Mississippi and Missouri, all practical steam-boat men agree that snag boat service is an undoubted, immediate, and positive benefit and assistance to navigation, removing danger of loss, not only to enormously valuable property in the shape of boats and merchandise, but of human life as well. There are other obstructions in the Mississippi River which are a source of dread and annoyance to pilots. They are the numerous wrecks which are found, especially in the bad reaches of the river. The amount of funds available have not justified the removal of these obstructions. As they are permanent and stationary, they are of less importance than snags, but a great benefit would be conferred on navigation by their removal, and it is earnestly recommended that an appropriation of $50,000 be made for the construction of a suitable vessel or wrecking boat for their removal. The machinery of the old snag boat *De Russy* is partly available for this purpose, and should be utilized.

With the appropriation recommended for the fiscal year ending June 30, 1890, it is proposed to continue the removal of obstructions as heretofore.

ESTIMATES.

For rebuilding one wooden snag-boat and fitting it up for wrecking purposes	$50,000
For working expenses of two boats, eight months each, at $4,000 per month	64,000
For repairs, incidental work, and contingencies	15,000
Total	129,000

Previous to the act of March 3, 1879, separate appropriations were not made for this work, but a general amount was appropriated, to be applied to several streams as their needs required. The appropriations made since then are as follows:

By act of—	
March 3, 1879	$100,000
June 14, 1880	100,000
March 3, 1881	89,000
August 2, 1882	85,000
July 5, 1884	75,000
August 5, 1886	56,250

Money statement.

July 1, 1887, amount available	$21,074.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17,302.29
July 1, 1888, balance available	3,772.47
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	103,772.47
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	129,000.00

MISSOURI RIVER.

Owing to the small amount of funds available for this work, the snag-boats were not sent to this river during the year.

The work in the Missouri River should be begun in the spring as early as the stage of water will permit and before the June rise; after this has subsided the low-water work should be done.

The benefit of the snag-boat service to the Missouri River is obvious; the necessity for the work has been set forth in the remarks on the Mississippi River. This stream is peculiarly liable to snags, as it has a constant tendency to change, and attacks its caving banks with great violence.

With the appropriation recommended for the fiscal year ending June 30, 1890, it is proposed to outfit the new snag-boat and work her in the river as long as the season and funds will permit.

ESTIMATES.

For outfitting and completing snag-boat	$10,000
For operating boat six months, at $4,000 per month	24,000
For repairs, incidental expenses, etc	10,000
Total	44,000

The first specific appropriation was made for this improvement on June 18, 1878; previous to this one appropriation was made to cover the needs of several streams. The appropriations made, beginning with that of June 18, 1878, are as follows:

By act of—	
June 18, 1878	$60,000
March 3, 1879	60,000
June 14, 1880	65,000
March 3, 1881	80,000
August 2, 1882	65,000
July 5, 1884	50,000
August 5, 1886	22,500

Money statement.

July 1, 1887, amount available	$6,193.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,445.29
July 1, 1888, balance available	2,748.25
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	44,000.00

W 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to Saint Louis, a distance of 41 miles, and 8 feet from Saint Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is Saint Louis, the program being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below Saint Louis (the natural width being in many cases from 1 to 1½ miles) and the protection of the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles, and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot; his office was in Saint Louis, and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush, stone, and piles, and of the towboat and barges engaged in that work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as fast as constructed; to keep the journal and other records of the work, to prepare pay-rolls, to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer. The superintending engineer was Mr. D. M. Currie. Resident engineers: At Pulltight, Mr. John O. Holman, for the revetment work done in the fall of 1887, and Mr. W. S. Mitchell, for the hurdle work done in the spring of 1888. The revetment work at Jim Smith's and the hurdle work at Sulphur Springs was under Mr. John O. Holman. The procurement of brush was under Mr. C. D. Lamb.

WORK ACCOMPLISHED.

Owing to the small amount of funds available the only work laid out for the year was the revetment of the artificial bank at the head of Pulltight and Jim Smith's, the construction of two hurdles at Pulltight Crossing, the partial wattling of the hurdles at Sulphur Springs, and the construction of Hurdles No. 16 of the Sulphur Springs system, at the head of Foster's Island.

Plate I is a general map of the river between the Saint Louis Bridge and Foster's Island, showing the location of these works.

HORSETAIL.

No work of construction was done at the locality; the hurdles closing the chute of Carroll's Island was damaged somewhat by the ice, and the high water has as yet prevented its repairs. A series of cross-sections was taken at Horsetail, showing the amount of fill accomplished here since the inauguration of the present contraction works. The work here may be considered as complete and has accomplished the desired result, that is the obtaining a good channel of at least 8 feet at low water. This locality was, before work was commenced, the most troublesome below Saint Louis; it is now a very rare occurrence for a steam-boat to cast the lead, when it was a common occurrence for several boats to be aground together at low water. The made ground here covers an area of 915 acres, 589 of which appear above a 15-foot stage of the Saint Louis gauge, whose zero is the low water of 1863, and this latter portion is covered with a thick growth of willows. The average fill has been 11.86 feet, the greatest fill was 40.5 feet. The amount of material deposited was about 17,500,000 cubic yards, at a cost of about 2½ cents per cubic yard. This shows what may be accomplished by this system when funds are available for continuous work. When a stretch of works can only be done partially and then left for want of appropriations the repairs are a very considerable item of expense.

Plate II shows the cross-sections and deposit at Horsetail.

TWIN HOLLOWS.

No work was done at this locality during the year. A series of cross-sections were taken, as at Horsetail, and the results shown on Plate III.

The area covered by material deposited is 361 acres; the area which appears above the 15-foot stage is 251 acres; the amount of material deposited is 11,389,259 cubic yards; average height of fill, 19½ feet, and greatest fill, 41.2 feet. The portion above the 15-foot stage is covered with willows. The channel at this locality is in good condition.

PULLTIGHT.

The original project for this locality was to send the channel down the east side of the river, by Beard's Island, making a crossing to the west side at Fine's Bluff, just above the mouth of the Meramec River. A study of this locality showed that the natural tendency of the river was to make the crossing above this point at White House, and at low stages there was a tendency to shoal; it was thought best to close the east side of the river by constructing hurdles and throw as much water as possible into the White House Crossing and improve and preserve this. With this view two hurdles were laid out and constructed, the first in prolongation of No. 4 of the Pulltight system and the second 2,800 feet below. The work was begun April 15 and continued until June 30. Hurdle No. 4 was built to a length of 3,025 feet, but owing to the rising river and a large run of drift it was damaged at several points and breaks made in it; there are 1,750 feet still intact. The repairs will be made as soon as the river falls sufficiently to work economically. Hurdle No. 5 was built for a length of 2,100 feet, and is now intact to a point 2,500 feet from the west bank of the river; several breaks caused by drift were repaired during its construction. These hurdles have caused a large deposit and have moved the middle bar at this point so that the low-water channel will be much improved. In the fall the

he work at this point consisted in the revetment
k opposite the head of Chesley Island; a length
tected, and the caving has been prevented. Th
ıt are in good condition, and have built up the new
ntended. A gap exists in the line of hurdle betw
1 of the Sulphur Springs system. This hurdle (No
ırder to accommodate the commerce here and all
ling. It is proposed to place this hurdle the comin
te IV.)

SULPHUR SPRINGS.

Vork at this locality consisted in the wattling of hurdl
ıction of Hurdle No. 16, at the head of Foster's Island
built for a length of 1,620 feet. A somewhat differen
ıloyed here—a departure from former methods (see R
gineers, 1887, Plate V, facing page 1564.) The drift-r
lumps in order to withstand she heavy run of drift w
ıng the spring rise. This hurdle completes the Sulphu
During the outrun of ice this season considerabl
the Sulphur Springs hurdles; the amount can not
ed until a fall in the river occurs. The work here has
y fill as shown on (Plate IV) and has closed the Foste
but high stages; in some places the fill has been ov
ws will grow on these bars this season or next. Pl
ars as they will appear at a 15-foot stage.

REMOVAL OF SNAGS.

plaints having been made by steam-boat owners
nger to navigation from snags, and no funds being
propriation for removal of obstructions in the Miss
tion was made October 27, 1887, for anthrac
$6,000 for the removal of

PLATE I.

or A. M. MILLER, Co

MIS

SAINT LOUIS

Showing loca

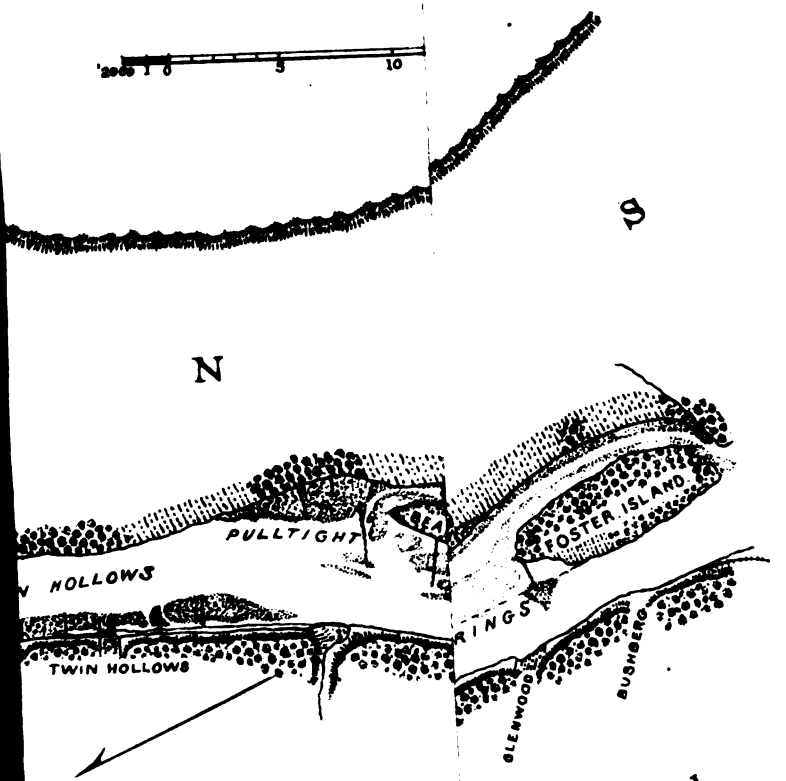
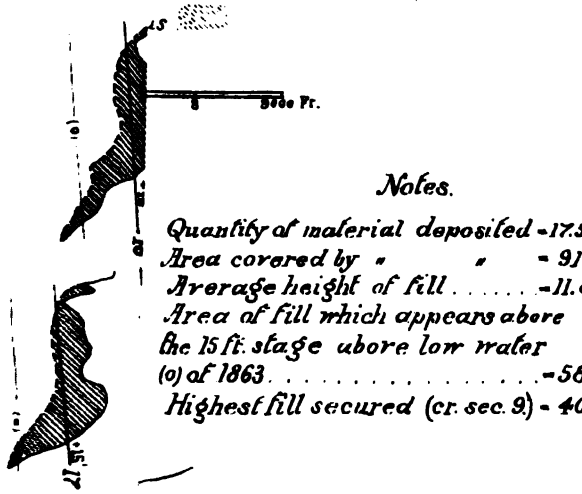


PLATE II.

'1880 to Mar.
:nce 1880.
'. above low

'hown thus



Notes.

Quantity of material deposited - 17.511925 cu. yds.
Area covered by " " - 915 acres.
Average height of fill . . . . . - 11.86 feet.
Area of fill which appears above
the 15 ft. stage above low water
(o) of 1863 . . . . . - 589 acres.
Highest fill secured (cr. sec. 9) - 40.5 feet.

U.S. Engineer Office, St. Louis, Mo. July 9. 1888.

2 *l report for the fiscal year ending June 30. 1888.*

A. M. Miller
Major Corps of Engineers.

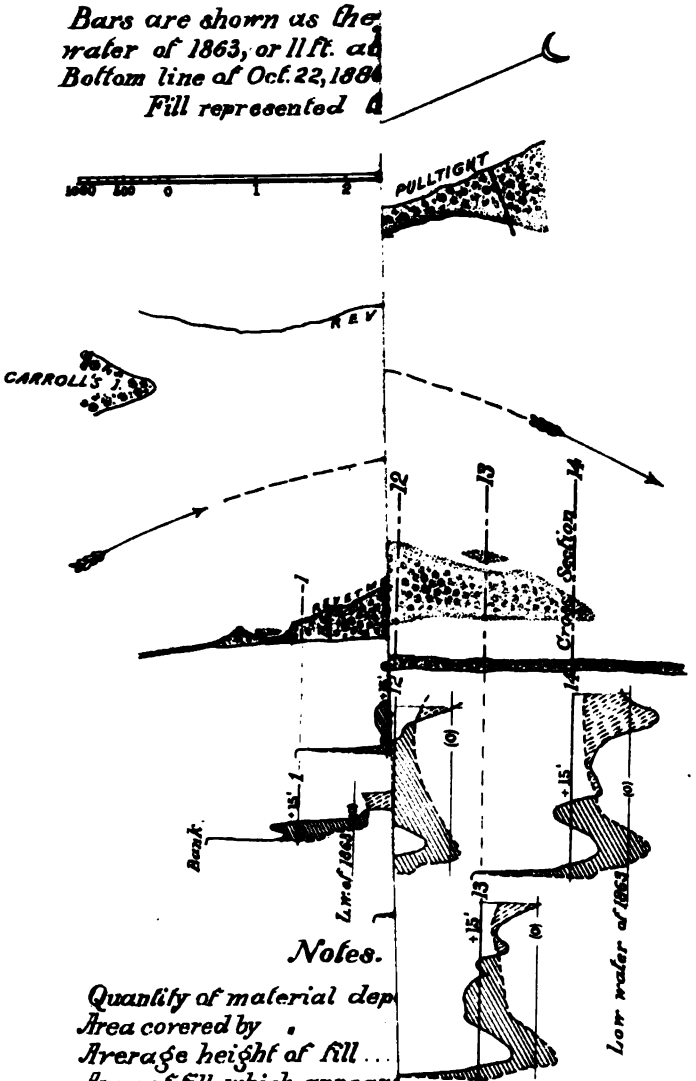
MI

PLATE III.

TWIN

CROSS SECTIONS
15, 1888, by the HURDLE

Bars are shown as the
water of 1863, or 11 ft. a
Bottom line of Oct. 22, 188
Fill represented



Notes.

Quantity of material dep
Area covered by
Average height of fill ...
Area of fill which appear
the 15 ft. stage, above low wa
of 1863. . . . . .
Highest fill secured (cr. sc

ffice, St. Louis, Mo. July 9. 1888.
cal year ending June 30. 1888.

A. M. Miller
Major Corps of Engineers.

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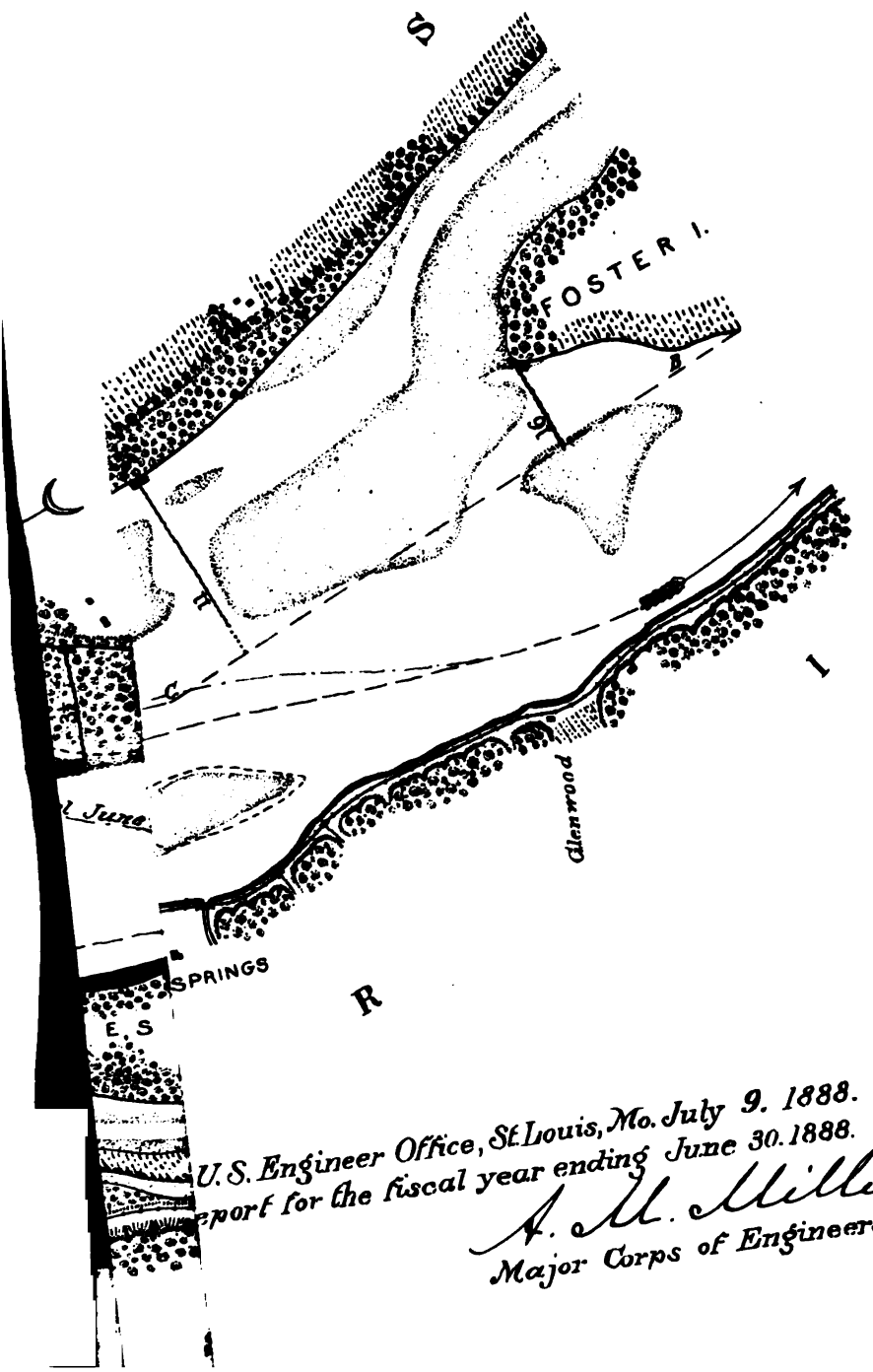
PLATE IV.



U. S. Engineer Office, St. Louis, Mo. July 9. 1888.
Report for the fiscal year ending June 30. 1888.

A. M. Miller
Major Corps of Engineers.

Stone was procured by contract in the fall from Glenwood Lime and Quarry Association at 47½ cents per cubic yard, and for the work in the spring from the Grafton Quarry Company at 40 cents per cubic yard.

Piles were obtained by contract with Mr. John Cleary at from 8 to 10 cents per linear foot according to length.

Rope, iron, wire, bolts, spikes, etc., were obtained by contract from various parties as per abstract of bids appended. Subsistence was purchased in open market on bids from various dealers.

SUPPLY DEPOT.

The supply depot was under the immediate charge of Mr. C. L. Stevenson until April 1, when he was obliged by sickness to go to hospital, since which date the supply and subsistence departments have been under the charge of Mr. S. S. Van Norman. All supplies, except brush, stone, and piles, as obtained were delivered at the depot, whence they were distributed on requisition to the various works. In addition to this function of the depot it was a general repair shop, where all repairs to plant, not requiring dockage, was made. During the season 10 pile-drivers were repaired; 23 barges caulked and repaired; 2 quarter boats caulked; and matress barges, flats, yawls, and skiffs repaired and put in order. Some minor repairs were made to the tow-boat *General Gillmore* and piles driven to replace the landing at depot.

The present valuation of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1887.	Debits.	Credits.	Balance June 30, 1888.
Barges, model and flat	$58,818.37	$7,635.06	$16,681.24	$49,772.19
Boat machine-shop	1,484.26	128.88	.....	1,613.14
Boats, quartet	1,777.15	625.68	997.39	1,450.44
Drivers, pile	36,467.00	1,843.12	4,883.50	33,426.62
Flats	4,869.13	1,479.18	2,966.97	3,381.34
Machinery, steamer *Humphreys*	6,000.00	.75	.75	6,000.00
Shanties, portable	14,305.00	707.67	3,425.62	11,587.05
Skiffs	722.62	614.02	688.62	648.02
Steamer *General Gillmore*	16,046.95	14,077.68	15,837.83	14,286.80
Tents	211.95	3.25	24.45	190.75
Ways for mattress	1,084.70	233.61	.....	1,318.31
Yawls	865.84	111.65	376.21	601.28
Supply depot	2,751.00	1,553.63	699.30	3,605.33
Tools and appliances	1,640.83	1,616.75	1,283.53	1,974.05
Boarding outfit	12,377.40	523.00	1,844.99	11,055.41
Office furniture	506.75	.....	96.28	410.47
Surveying instruments	616.31	95.00	137.10	574.21
Photographic apparatus	222.75	.....	22.27	200.48
Total	160,768.01	31,248.93	49,966.05	142,050.89

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the season. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Saint Louis and New Orleans Pilot Association during the low-water season, are appended, marked B.

The river was closed to navigation by ice from December 21 to 31 and from January 21 to 31. The low-water season continued from the middle of July till the close of navigation by ice.

The least depth of water reported was $4\frac{5}{6}$ feet at Fort Chartre Kinney Point, while the least depth reported by the same boa steamer *Arkansas City*, on the same date, October 28, in the imp portion of the river, was $6\frac{1}{2}$ feet at Sulphur Springs. The wat lower than usual this year.

SURVEYS.

A survey of the river was made in the fall of 1887, and extende the foot of Beard's Island to Cliffdale Hollow, a distance of $17\frac{1}{2}$ The object of this survey was to locate the bars and changes portion of the river under improvement, and to obtain data upon to locate work for an extension of the system of improvement.

The party was in the field from September 19 till November 2 the work was platted to a scale of $\frac{1}{5000}$. (See report of Mr. Mitchell.)

Cross-sections were taken in the spring of 1888 at Horsetai Twin Hollows, to show the fill at these localities. The results app Plates II and III.

COMMERCIAL STATISTICS.

The commercial statistics below were obtained partially from th chant's Exchange of Saint Louis and partially from other so Great difficulty was met with in placing a valuation on miscella or general merchandise. The tonnage transferred across the ri ferries is estimated at $60 per ton. In the table below the genera chandise has been estimated at $30 per ton; this is considered estimate.

Receipts and shipments at Saint Louis during the year ending December 31, 1

River.	Articles.	Receipts.		Shipment	
		Tons.	Estimated value.	Tons.	Est v
Mississippi below Saint Louis.	Merchandise and grain*	268, 735	$8, 853, 114. 68	538, 065	$21, 3
Mississippi above Saint Louis.	.....do*	132, 400	3, 605, 257. 03	36, 170	1, 0
Missouri	.....do*	27, 700	982, 460. 05	14, 580	4
Illinois	.....do*	78, 560	895, 652. 86	7, 125	2
Ohio	Merchandise and iron ore.*	121, 670	1, 924, 252. 83	19, 035	6
Cumberland and Tennessee.	Merchandise and grain*	23, 815		18, 715	
Red and Ouachita	.....do*	.....	.....	3, 370	1
Mississippi above Saint Louis.	Lumber, shingles, etc*	213, 165	2, 431, 215. 93	.....	.....
Mississippi below Saint Louis.	.....do*		267, 115. 08	.....	.....
Mississippi below Saint Louis and Missouri.	.....do*		52, 683. 26	.....	.....
Mississippi between Saint Louis and Cairo.	Flour, grain and brant.	.....	.....	34, 457	1, 0
Total	.....	866, 045	19, 011, 751. 72	671, 517	24, 8

*Tonnage obtained from Saint Louis Merchants' Exchange report. Values estimated from prices given by commercial papers and dealers.

† Tonnage from steam-boat manifests. Values from average prices.

Recapitulation.—1,537,562 tons, valued at $43,901,034.90.

REPORTS OF ASSISTANTS.

There are submitted herewith the reports of the superintending engineer, Mr. D. M. Currie, and the reports of assistants, by reference to which all details and particulars can be obtained.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1890, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted. That is, to carry on the work of improvement continuously from Saint Louis down-stream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet; alluvial banks to be protected from erosion. It is proposed by this means to obtain a channel of at least 8 feet at low-water. The depth now is liable to become as small as 4 feet, or even less in some places, and less than 8 feet at every locality where the width is more than 2,500 feet. In my last report I asked for the same amount, but the river and harbor bill, as just passed both houses of Congress, appropriates only $300,000. With this sum it is not possible to make the proper progress necessary for so important a work, and the steam-boat interests are suffering from such small appropriattions.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was	$16,997,100.00
The aggregate amount appropriated to June 30, 1888, is	3,739,600.00
The amount expended to June 30, 1887, is	3,521,508.50

Abstract of appropriations made for present plan of improvement.

By act of—	
March 3, 1873	$200,000
June 23, 1874	200,000
March 3, 1875	200,000
August 14, 1876	229,600
June 18, 1878	260,000
March 3, 1879	215,000
June 14, 1880	320,000
March 3, 1881	620,000
August 2, 1882	600,000
July 5, 1884	520,000
August 5, 1886	375,000

Money statement.

July 1, 1887, amount available		$216,173.02
Miscellaneous receipts		1,708.63
		217,881.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$122,195.19	
July 1, 1888, outstanding liabilities	28.09	
		122,223.28
July 1, 1888, balance available		95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
Amount available for fiscal year ending June 30, 1889		395,658.37

Amount (estimated) required for completion of existing project	12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for furnishing piles, stone, manilla rope, sisal rope yarn, oakum, wire, nails, spikes, screw-bolts and iron, opened March 31, 1888, *by A. M. Miller, Corps of Engineers, Saint Louis, Mo.*

No.	Name and address of bidders.	Piles.			Stone.		Manilla rope, 3,500 lbs., per pound.
		1,100, 30 to 35 feet, per foot.	2,800, 36 to 45 feet, per foot.	1,100, 46 to 60 feet, per foot.	6,500 cubic yards, per cubic yd.	Distance of quarry.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Miles.*	*Cents.*
1	W. D. Bangs, Saint Louis, Mo.[1]	.....	.....	.....	.....	.....	[2]10.375
2	W. H. Langdale, Saint Louis, Mo.[1]	.....	.....	.....	.....	.....	10.75
3	John Cleary, Chester, Ill	[2]8	[2]9	[2]10	.....	.....	.....
4	Myron M. Buck, Saint Louis, Mo.[3]	.....	.....	.....	.....	.....	10.75
5	William H. B. Stout, Lincoln Nebr.[1]	10	12	15	.....	.....	.....
6	Harry E. Coffin, Memphis, Tenn	.....	.....	.....	.....	.....	10.45
7	John W. Reno, Point Pleasant, Mo	10	10	11	.....	.....	.....
8	H. L. Fox & Co., Saint Louis, Mo	16.5	16.5	16.5	.....	.....	10.73
9	William Burg, secretary Ewald Iron Company, Saint Louis, Mo.[4]	.....	.....	.....	.....	.....	.....
10	B. F. Johnston & Co., Saint Elmo, Ill.[1]	12	14	15	.....	.....	.....
11	J. S. Roper, secretary Grafton Quarry Company, Saint Louis, Mo	.....	.....	.....	[2]40	([5])	.....
12	James J. Hawk, Saint Louis, Mo	.....	.....	.....	.....	.....	10.6
13	Louis Grund, Saint Louis, Mo	.....	.....	.....	57	([6])	.....
14	Silas De Main, Saint Louis, Mo	.....	.....	.....	.....	.....	.....

No.	Name and address of bidders.	Sisal yarn, 1,700 lbs., per pound.	Oakum, 2,000 lbs., per pound.	Wire, 10,000 lbs., per pound.	Nails, 11,200 lbs., per pound.	Spikes, 9,000 lbs., per pound.	Screw-bolts, 6,000, each.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	W. D. Bangs, Saint Louis, Mo.[1]	[2]9.75	.....	.....	.....	.....	.....
2	W. H. Langdale, Saint Louis, Mo.[1]	.....	8.6	.....	.....	.....	.....
3	John Cleary, Chester, Ill	.....	.....	.....	.....	.....	.....
4	Myron M. Buck, Saint Louis, Mo.[3]	.....	[2]8	3.6	2.1	([6])	[7]2.5
5	William H. B. Stout, Lincoln, Nebr.[1]	.....	.....	.....	.....	.....	.....
6	Harry E. Coffin, Memphis, Tenn	9.95	.....	3.62½	2.29	[2]2.75	9.58
7	John W. Reno, Point Pleasant, Mo	.....	.....	.....	.....	.....	.....
8	H. L. Fox & Co., Saint Louis, Mo	10.49	.....	3.62	[2]2.04	2.84	[2]8.7
9	William Burg, secretary Ewald Iron Company, Saint Louis, Mo.[4]	.....	.....	.....	.....	.....	.....
10	B. F. Johnston & Co, Saint Elmo, Ill.[1]	.....	.....	.....	.....	.....	.....
11	J. S. Roper, secretary Grafton Quarry Company, Saint Louis, Mo	.....	.....	.....	.....	.....	.....
12	James J. Hawk, Saint Louis, Mo	11½	8.75	[2]3.24	.....	.....	.....
13	Louis Grund, Saint Louis, Mo	.....	.....	.....	.....	.....	.....
14	Silas De Main, Saint Louis, Mo	.....	.....	.....	.....	.....	8.7

[1] Slight informality in proposals.
[2] Contracts awarded.
[3] Guaranty incomplete.
[4] No guaranty. Prices not in detail.
[5] Grafton, 40 miles.
[6] Saint Louis.
[7] Screw-bolt proposal by pounds.
[8] ⅝ inch at 2½ cents, ¼ inch at 3 cents.
[9] $173 for lot.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *July* 5, 1

SIR: I have the honor to submit the following report on the improvements Mississippi River in this vicinity during the fiscal year ending June 30, 1888, transmit as parts thereof the reports of the superintendents in local charge.

Works were prosecuted at Pulltight, Jim Smith's, and Sulphur Springs by labor, but with plant owned by the Government. Materials, where the cost wa siderable, were purchased by contract, and by purchase in open market wher were not.

At Pulltight the bank was protected for a distance of 1,825 feet from the head of the works to Hurdle No. 1, by a mattress of the usual form and width placed below the level of standard low water and a revetment of stone between that and the top of the bank.

Two lines of hurdles were built; one, designated No. 4, was practically an extension of No. 4 of the old series, although not a continuation of its course, and extends about 3,000 feet from the willow bar with which it connects; the other is located 2,800 feet below and extends a distance of 2,100 feet from the west face of Beard's Island. These reduce the width of water-way to 2,500 feet. In height these hurdles were intended to have the stringers 25 feet, and 20 feet above low water in the drift and hurdle-rows respectively, but the water was higher than the latter height while they were being built, ranging in stage from 22 feet to 29 feet, causing the stringers to be placed not lower than 25 feet in either row.

No. 4 was broken in several places in crossing a secondary high-water channel between points 1,700 feet and 2,800 feet from shore, and could not be repaired economically at the prevailing stage of water. For further detail reference is made to the report of Mr. William S. Mitchell, superintendent.

At Jim Smith's the new bank was protected for a distance of 1,775 feet between Hurdles 2½ and 3½ by placing a mattress of the usual form below standard low water and a stone revetment above it, as follows: Beginning 100 feet from the head of the mattress, for a distance of 1,225 feet stone was placed from the mattress to the top of the bank, and on the remaining 450 feet from the mattress to the foot of a vertical cut 5 feet below the top of the bank.

The details of the work are given in the report of Mr. John O. Holman, superintendent. At Sulphur Springs, Hurdles Nos. 6, 7, 9, and 11 were completed by wattling their ends as follows: No. 6 for 765 feet, No. 7 for 760 feet, No. 9 for 615 feet, and No. 11 for 1,125 feet. In addition, a new line, No. 16, was built to a distance of 1,620 feet from the head of Foster's Island. It extends to a point 100 feet west of the proposed new bank of the channel-way.

The form of construction used in this hurdle promises to become a standard type, and is especially suitable for work during high water or while drift is running in considerable quantities.

It consists of drift row, hurdle row, with its braces, and a mattress, and differs from former types in having the drift row driven in clumps of piles in order to secure freedom from drift while constructing the hurdle row, mattress, and wattling. The mattress can not extend over the drift row on account of the clumps; still there is little danger of damage by scour with the mattress reaching well above the hurdle row if the completion of the line follows rapidly the establishment of the drift row.

Mr. Holman's report shows further details. Brush was procured by hired labor and the payment of a royalty, under the local supervision of Mr. C. D. Lamb, whose report gives all details.

The plant was not increased during the year, but was considerably repaired. Its capacity for transportation of material was diminished by the conversion into quarters, with portable buildings, two barges and one large flat which from age had become unfit for heavy service.

Mr. Van Norman's report shows the details of the repairs and changes.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM T. MITCHELL, SUPERINTENDENT.

SAINT LOUIS, MO, *June* 30, 1888.

SIR: I have the honor to submit the following report on the work done at Pulltight, Ill., during the fiscal year ending June 30, 1888.

The operations of the first half year were conducted under Mr. J. O. Holman, and the account here given is taken from his semi-annual report of December 31, 1887.

The work consisted of a revetment placed to protect the caving bank, which had been formed by the old hurdles, between the upper end of the primary hurdle and secondary hurdle No. 1, a distance of 1,700 feet. The low-water portion of the revetment consisted of a brush mattress 120 feet in width, except for 160 feet in the angle between the bank and the primary line, where the width was necessarily reduced, averaging only 72½ feet.

The shore edge of the mattress was placed at the level of standard low water, 4 feet on St. Louis gauge. Near the upper end of the work the banks of a circular cave

Whitehouse. During construction it was broken four times by drift and the scouring out of piles by the current before the mattress was sunk. The first and second breaks, both from the latter cause, occurred in the west portion of the line, and in nearly the same place, and both times the weakened piling gave way while the mattress was being sunk. The two sections of piling and mattress, aggregating 275 feet in length, were loss. The heavy drift then running contributed largely to the damage. The line was repaired here by constructing a section of hurdle in front of the break and 100 feet above it and connecting the two hurdles at the ends by single rows of braced piles. This was done to avoid building in the deep water in the gap. This section of the hurdle was partly wattled and partly screened by curtains to the 25-foot level to offer as nearly as possible the same resistance to the passage of the water as was done by the drift on the remainder of the line.

The other breaks were caused by the destruction of the braced piling under the great pressure of drift accumulated in front of them, and occurred in the deep water from 30 feet to 125 feet from the island shore, and were 75 feet and 40 feet in width, respectively. The drift row in the vicinity of these breaks was partially destroyed for 200 feet. Both of these breaks were repaired. The drift row across them was restored with clumps of piles, and the lower row was doubly braced and strengthened with clumps and cross-braces to the upper row. These repairs were finished June 29, completing the season's work, and on the following day the plant was removed to the harbor at Bushberg, Mo.

The aggregate length of hurdles constructed is 5,125 feet, for which 5,588 feet of mattress about 85 feet in length were fabricated. The piles (1,979) were driven to an average depth, 15.5 feet, part of this driving, on Hurdle No. 4, being very difficult on account of an underlying stratum of gravel. About 30 braces were placed with clevises, but the remainder (676) were driven an average depth, 6 feet below the mattress, and pulled over into place. About one-third of the braces were framed into the piles, but on account of high water the remainder were bolted with two bolts, one through the pile and one through the stringer on which the brace rested. This joint is thought to be capable of resisting quite as great a strain as the pile itself, and can be made much quicker and cheaper than the framed joint.

The force employed was about 250 men until May 28, when about 30 per cent. of them were sent to Foster's Island to begin works there, and after that the force was slowly reduced as the work was completed until, at the close of the season, about 110 remained.

The results obtained by these hurdles are already very satisfactory, large deposits having been gained below each of them and a great erosion in the bar outside of them. It is hoped that both these results will be largely increased during the high water now prevailing.

* * * * * * *

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

SAINT LOUIS, MO., *June* 30, 1888.

SIR: I have the honor to submit herewith the following report of the operations at Jim Smith's for the fiscal year ending June 30, 1888.

The caving bar at the channel crossing near the upper end of the works was protected by a low-water mattress, extending from a point 300 feet below Hurdle No. 2½ to Hurdle No. 3½, a total length of 1,775 feet, or 213,000 square feet. The entire mattress was built to the full width of 120 feet, except at Hurdle No. 3, which projected about 20 feet into the river beyond the bar line. At this point an opening 40 feet long by 20 feet in width was left in its inner edge so that the mattress when placed would fit closely around the hurdle.

The mattress was woven in the usual manner on 25 weaving poles placed 5 feet apart. To strengthen the river edge two continuous poles were placed over the outside weavers, wired to them and to the brush beneath. Owing to the low stage of the river the mattress was easily placed. A small shore-mattress 60 feet long by 50 feet in width was constructed and placed inside of the low-water mattress to protect the circular cave just below Hurdle No. 3.

The caving bar was also revetted a length of 1,675 feet, nearly the full length of the low-water mattress, 1,250 feet at the upper end to the top of the bar, and 425 feet at the lower end only, to the bluff bank, the latter distance being left without grading

it. A length of 100 feet at the head of the mattress was not revetted. The total covered with riprap was 65,425 square feet, an average width of 39 feet, with an a age thickness of 0.9 foot for the riprap placed.

Quarter-barges Nos. 13 and 58 were in service for the mattress crew twenty-six from September 16 to October 10, with a maximum force of 102 men, of whom 35 sisted themselves. The latter crew placed the riprap during October from the 15 the 31st.

The location of the work done is shown on the sketch accompanying this rep

I remain, very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintend

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTNDENT.

SAINT LOUIS, MO., *July* 2, 18

SIR: I have the honor to submit herewith the following report of the operation Sulphur Springs for the fiscal year ending June 30, 1888.

Wattling the river ends of Hurdles Nos. 6, 7, 9, and 11 was the only work dor this locality during the fall season of 1887. In the spring season of 1887, when t hurdles were, constructed, the wattling was not placed their full lengths, owing t large quantity of drift-wood and the strong current at their river ends.

During November, 1887, from the 1st to the 17th, the amount of work done, g in the following table, finished the wattling of these hurdles to the height of hurdle stringer.

Amount of wattling placed.

	Linear feet.	Sq fe
No. 6	765	
No. 7	760	
No. 9	615	
No. 11	1,125	
Total	3,265	

The maximum number of persons employed was 71, of whom 26 subsisted selves.

In the spring season of 1888, from May 28 to June 30, Hurdle No. 16 was constru It was built to a length of 1,620 feet, extending from the head of Foster Island point 100 feet beyond the river line of the works. Two rows of piles were driv this hurdle, with a space of 22 feet between the rows. The piles in the upp drift-row were driven 11 feet apart; those in the lower or hurdle row 6 feet a Every third pile in the drift row was strengthened by two additional ones, o which was driven from 3 to 7 feet to the side and one the same distance belo the space varying with the depth of water. These piles were drawn togethe bolted to the drift stringer, forming a clump of 3 piles at every third interval i drift row.

Stringers were placed along each row—the drift stringer as soon as the piles driven, the hurdle stringer after the mattress was placed.

A foundation mattress of brush was constructed and placed the full length o hurdle. Its width was 65 feet, 50 feet below the hurdle row and 15 feet abo with the up stream edge about 6 feet below the drift row. It was woven on fla the usual manner, 2 flats above and 5 flats below the hurdle row. For a distan 650 feet from shore, where the water averaged 30 feet in depth, the mattress was in sections of about 200 feet in length, but on the bar at the outer end of the hu where the water was but 12 feet in depth, the mattress was made continuous. only difficulty experienced in sinking the mattress was at the shore end, where water was 40 feet deep.

During the month while the work was in progress the river was high, the S Louis gauge reading from 23 to 29 feet above low water.

A mattress 290 feet long by 80 feet in width was placed at the shore end of the *dle with riprap above it* to the foot of the bluff bank.

the mattress was sunk and the hurdle stringer placed, brace piles were driven the hurdle row, pulled up to it, and bolted both to the hurdle pile and to the stringer. The braces were driven from 9 to 14 feet through the mattress. In eep water they were spaced 12 feet apart, about 15 feet below the hurdle row. e bar at the river end they were spaced 18 feet apart and driven only 4 feet be- he row. The drift row was braced by cross-stringers placed at every other drift at the shore and river ends and every third drift pile on the bar near the middle he hurdle.

urtain mattresses, averaging about 60 feet in length with a depth of 15 feet, were ced above the hurdle piles for a distance of 400 feet from the shore. They were ven on poles spaced 6 feet apart, lowered into place with the lines and the poles iled to the piles above the water. A layer of brush about 1 foot in depth was af- rwards wattled on the hurdle piles, the wattling holding the poles of the mattress lose to the piles. When placed the top of the curtain mattresses were at the 11-foot tandard stage, about the level of the bar at the river end of the hurdle.

The amount of work done on the different parts of the hurdle is given in the following table:

Kind of work.	Number.	Depth driven.	Kind of work.	Linear feet.	Square feet.
Piles	522	8,871	Mattress	1,874	126,260
Braces	93		Wattling	395	5,659
Stringers	165		Revetment	225	3,500

The maximum number of persons employed at any one time was 123.

The sketch of the works accompanying this report shows the location of the work done. Owing to the high stage of the river entirely covering the upper hurdles the extent of damage done to them by ice during the winter months could not be ascertained.

I remain, very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

SAINT LOUIS, MO., *June* 30, 1888.

SIR: I have the honor to submit the following report on the procuring of brush during the fiscal year ending June 30, 1888.

In accordance with instructions received September 5, 1887, a force was organized and the cutting of brush begun September 9 at Horsetail Bar, west side, on land belonging to the Thomas Allen estate, but leased to the Saint Louis, Iron Mountain and Southern Railroad Company.

The brush procured there amounted to 1,444.4 cords, all grown on land made since 1881 by the hurdles built at that time. The force was removed October 4 to the tow-heads on the Missouri side of Cabaret Island, where 609 cords of brush were procured from land for which no owner was found.

The force was removed from that locality October 13 to Sycamore Landing, on the Illinois shore, opposite Brickey's Mill, where it remained until October 27, when it was disbanded for the season. The brush cut at this place amounted to 768.6 cords, for which a royalty of 10 cents per cord was paid.

The brush procured during the half year amounted to 2,821.6 cords.

The work was resumed for the spring season of 1888 on the 9th of April, at Durfee's Landing, on the Illinois shore at the head of Fish Bend, where 759 cords of brush was procured, on which the usual royalty was paid.

The force was removed April 19 to the tow-head next above Turkey Island, from which 775.6 cords of brush was procured between that date and April 23, when the force was moved to the tow-heads opposite Saint Genevieve, where 1,530.9 cords of brush was procured, on 980.9 cords of which a royalty of 10 cents per cord was paid but no owner was found for the remainder nor for the brush cut from Turkey Island tow-head.

The force remained on these tow-heads until May 25, when it was removed to the Illinois shore near the head of Calico Island, where, after procuring 90.3 cords

brush, for which no royalty was paid, the force was disbanded for the season on the 28th of May.

The brush procured during the last half year amounted to 3,155.8 cords, and the total for the fiscal year to 5,977.4 cords.

* * * * * * *

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VANNORMAN, ACTING SUPERINTENDENT.

SAINT LOUIS, MO., *June* 30, 1888.

SIR: I have the honor to submit my report of operations at the engineer supply depot connected with works of improvement under your charge, for the fiscal year ending June 30, 1888.

Following is a general account of work done on each class of plant under supervision of the superintendent of supplies.

Towboat.—The wheel of the steamer *General Gillmore* was repaired by removing keys, braces, buckets, and wheel arms. Small boat was calked and machinery lined up. Three fenders, one flag-staff, one ladder, and one ice-chest were made for the boat, and two skylights placed on the after part of her roof.

Pile-drivers. — Nos, 7, 8, 11, 12, 13, 15, 16, 17, 18, 19, and 20 were calked at their rake ends and chocks, kevels, and braces to leads renewed.

New roofs were placed on Nos. 10 and 19, and roof of No. 12 repainted.

The side braces of leads for nine drivers were fitted with angle-irons to protect the braces.

Barges.—Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 21, 24, 28, 29, and 30 were calked above water-line, pumps repaired, and bits and chocks refastened.

Of the above, thirteen barges were calked twice during the year, and new capstans placed on five.

Barge No. 19 was side-docked, and knuckle and saddle planking renewed where necessary.

Barges Nos. 14, 25, 26, and 27 were hauled out on the ways and thoroughly calked below the water-line, Nos. 25 and 27 being repaired as follows: Stern-pieces, futtock, saddle, knuckle and grub-strake planking, and hood and planking all renewed, stem bands reshaped and fastened, and top timbers spliced.

No. 14 had short pieces of planking below the water-line and one saddle plank renewed and 30 top timbers spliced.

Hog chains and braces were removed from barges 14 and 16, and 8 sections of portable quarters placed on each.

Side planking on barge No. 22 was removed where necessary, sides above water-line calked, and pumps repaired.

Barge flats. — Nos. 57 and 58 were calked twice at the rake ends, deck and deck beams of No. 58 renewed, and office quarters placed on the latter.

Quarter boats.—The rake ends of Nos. 5 and 7 were calked.

Mattress barges.—No. 3 was calked twice above the water-line, pumps repaired, timber heads refastened, and capstan, chocks, plank-shear, platform, brackets to extension platform, and fingers to ways, renewed.

Ways for mattresses.—Twelve sets of ways and standards were made during the year.

Flats.—A cabin was placed on one for use of survey party and 75 were hauled out on the bank at the depot in the fall of 1887. Seventy-nine flats were repaired during the year as follows: Bottoms were patched, gunwales spliced, caps, head-blocks, kevels, and ring-bolts renewed, and all thoroughly calked.

Skiffs.—Thirteen were stored under shelter at the depot, and 29 repaired by renewing and patching sides and bottoms, renewing skegs, row-locks, and oar-pins, and calking.

Yawls.—Fourteen were repaired during the year by calking and patching.

Tools and appliances.—Forty-three handles for hurdling-forks, 30 signal-poles, 21 capstan-bars, and 3 pike-poles were made at the depot during the year. Fifty-four wheelbarrows, 6 double blocks, 3 pike-poles, 19 cant-hooks, and 10 hurdling-forks were repaired, principally by renewing handles to poles, hooks and forks, and legs, beds, and head-pieces to wheelbarrows.

Portable buildings.—Three sections were erected at the depot for the purpose of storing machinery. Sixteen sections were put upon barges for quarters. Twenty-

four sections of quarters were removed from the bank at East Sulphur Springs and brought to the depot for storage. Two water closets were built for quarters on barges.

Boarding outfit.—Seventeen bunks were nailed together for use at the works.

Supply depot.—A platform scale, capable of weighing 10 tons, was put in at the depot.

Four clumps of piles were driven along the river front of the depot for mooring purposes and a superstructure of piles placed for a new landing.

A new cellar door for subsistence warehouse was made and one repaired.

The office of the depot was painted and provided with screen doors and windows.

One thousand and thirty-nine screw-end bolts and numerous other smaller appliances were made at the depot and sent to the works.

All tools and appliances in the field requiring repairs were sent to the depot for that purpose.

* * * * * * *

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Acting Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VAN NORMAN, SUPERINTENDENT.

SAINT LOUIS, MO., *June* 30, 1888.

SIR: I have the honor to submit my report of operations in the subsistence department connected with works of improvement under your charge, for the fiscal year ending June 30, 1888.

The average number of men subsisted daily, during progress of work, was 190, and the average cost per ration 46 cents, including all expenses for labor employed in connection with subsistence.

The labor was employed as follows:

Procuring and distributing supplies at the engineer depot at Saint Louis; receiving, preparing, and serving same, and policing mess-rooms, kitchens, and quarters in the field, and consisted of the following class of employés: Superintendent of subsistence, boarding-masters, cooks, and waiters.

The following table shows the average cost of feeding employés, for each year, from the time the present subsistence department was organized, March, 1882, to date:

Year.	Average number of men subsisted daily.	Average cost of ration.
		Cents.
March to June, 1882	736	47
Fiscal year ending June 30—		
1883	694	45
1884	268	42
1885	509	39
1886	210	39
1887	382	36
1888	190	46

The increase in cost of the ration for 1888, as compared with previous years, is attributable in part to the small number of men subsisted, the short time that work was in progress, and the increased cost of several of the principal articles of subsistence.

Work in the field was commenced in September, 1887, with an average of 103 men, who were subsisted 23 days, 119 men during October, and 69 men for 23 days in November, when work was suspended.

Operations in the field were resumed in April, 1888, with an average of 322 men for 22 days, 279 men during May, and 249 men for June, 1888, when work was again suspended.

The cost of the ration is considerably more near the commencement and suspension of work than when the forces are fully organized and in the field; as at commencement the boarding-masters, cooks, and waiters are employed several days in receiving supplies and generally preparing for reception of the men, before the latter can commence work, and when operations are suspended the subsistence crews are continued

on duty for some time after other employés are discharged, in washing and packing away bedding and cleaning quarters, mess-rooms, and kitchen.

Therefore, the fact that work was twice commenced and suspended during the year should also be considered in connection with the increased cost of the ration.

The above report refers only to subsistence for employés engaged on works of construction, in addition to which the average cost of the ration on the tow-boat *General Gillmore* during the year was 48 cents, and 63 cents per ration for a survey party of 12 persons for 23 days in February and March, 1888.

The manner of procuring and distributing supplies, variety and quality of same, bill of fare, allowance, etc., are given in detail in my report for 1883, which may be found in Appendix T, page 1244, Report of the Chief of Engineers for 1883.

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *January* 2, 1888.

SIR: I have the honor to submit the following report of the operations of the survey party under my charge during the half year ending December 31, 1887.

The section of the river embraced by the survey was that between the foot of Beard's Island and Cliffdale Hollow, a distance of 17½ miles.

The instructions were to locate the banks, islands, sand-bars, and general topography with a plane table, using, whenever they could be found, the triangulation points established in 1874–'75, and when these points were too few to insure accuracy to interpolate new triangulation points with a transit.

The topography was to be depicted on two sheets which were prepared in the office before the party went into the field. The first sheet was to extend from the foot of Beard's Island to Lucas's Bluff, and the second from Lucas's Bluff to Cliffdale Hollow.

In addition the river was to be sounded in cross-sections 1,000 feet apart and the soundings to be located, the stage of river being referred to the bench-marks established in 1879–'80. As it was desired to have all soundings taken at as nearly the same stage of river as practicable, it was decided to complete the topography of the entire reach before beginning the soundings.

A quarter-boat having been fitted out, the party was organized and was placed by the steamer *General Gillmore* at Chesley Island, and on September 19 the survey was begun. The first chart was completed on October 14 and the second on October 31. For the lower chart it was found necessary to establish three new triangulation points, and for that purpose secondary points established by the Mississippi River Commission were used after connecting them with the triangulation of this office. In all, about 80 miles of bar and shore-lines were depicted.

Between November 1 and 14 the party was engaged in sounding, and in the entire reach 3,495 soundings were taken and recorded in 77 cross-sections of the river. At the same time the bar-lines were corrected for slight changes which had been developed by the fall in the stage of the river since they were first located.

This work was somewhat delayed by the fogs and the smoky atmosphere which prevailed until the end of the season. No other special difficulty was encountered, the low stage of the river and the long-continued dry weather being most favorable to the prosecution of the survey.

On November 15, the party was removed to Whitehouse, Mo., and a survey was begun to locate, on a tracing from the chart of last spring, the shore and bar-lines developed by the lower water of the fall between the upper ends of the works at Pulltight, Ill., and Jim Smith's. This portion of the river was also sounded, 1,073 soundings being taken in 23 cross-sections, spaced 1,000 feet apart, except over the Twin Hollows Bar, where the distance between the sections was reduced to 500 feet.

Field-work ended on November 22, when the quarter-boat was taken to Bushberg, Mo., for the winter, and the notes and charts brought to the office to be completed.

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Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

CONSTRUCTION ACCOUNT.

Name of work.	Expended prior to July 1, 1887.	Expended during fiscal year ending June 30, 1888.	Total cost to June 30, 1888.
Piasa Island:			
Dam	$32,333.30		$32,333.30
Dam (cutting channel)	3,116.86		3,116.18
Alton Dam	33,740.05		33,740.05
Alton Dike	76,652.74		76,652.74
Sawyer Bend protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
Arsenal Island protection	42,509.06		42,509.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite Saint Louis	58,455.54		58,455.54
Horsetail Bar:			
Dike 1	40,549.53		40,549.53
Dike 2	23,600.26		23,600.26
Dike 3	82,692.54		82,692.54
Dike 4	41,290.11		41,290.11
Dike 5	36,933.87		36,933.87
Training-wall	81,253.28		81,253.28
Hurdles	548,834.08		548,834.08
Bank protection	40,993.55		40,993.55
Twin Hollow:			
West side, hurdles	248,837.82		248,837.82
West side, bank protection	19,161.31		19,161.31
East side, bank protection	128,920.30		128,920.31
Beard's Island:			
Primary hurdle	7,166.24		7,166.24
Bank protection	84,258.76		84,258.76
Jim Smith's hurdles	309,108.46	$18,824.98	327,933.44
Pulltight hurdles	123,600.40	81,875.34	205,475.74
Chesley Island:			
Bank protection	64,416.04		64,416.04
Hurdles	27,808.61		27,808.61
Sulphur Springs, hurdles	152,717.26	25,246.98	177,964.24
Foster Island	44,296.02		44,296.02
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,468.85
Kaskaskia, protection	66,465.62		66,465.62
Liberty Island:			
Dam	5,053.91		5,053.91
Protection	45,129.40		45,129.40
Devil's Island:			
Dike 1	65,871.17		65,871.17
Dam 1	49,848.58		49,848.58
Dam 2	16,678.30		16,678.30
Minton Point, hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdle	31,930.18		31,930.18
Cairo, protection	160,4 9.82		160,439.82
Removing obstructions, snag-boat *Wright*		4,280.45	4,280.45
Totals	3,142,569.74	130,227.75	3,272,797.49

PROPERTY AND MATERIAL ACCOUNT.

Class of property.	Balance July 1, 1887.	Debits.	Credits.	Balance June 30, 1888.
Steamer *A. A. Humphreys* (machinery)	$6,000.00	$0.75	$0.75	$6,000.00
Steamer *General Gillmore*	16,046.95	14,077.68	15,837.83	14,286.80
Barges	58,818.37	7,635.06	16,681.24	49,772.19
Barge flats		529.18	529.18	
Pile-drivers	36,467.00	1,843.12	4,883.50	33,426.62
Ways	1,084.70	233.61		1,318.31
Quarter-boats	1,777.15	625.68	997.39	1,405.44
Quarters	14,305.00	707.67	3,425.62	11,587.05
Tents	211.95	3.25	24.45	190.75
Supply depot	2,751.00	1,553.63	699.30	3,605.33
Machine-shop	1,484.26	128.88		1,613.14
Flats	4,869.13	1,479.18	2,966.97	3,381.34
Skiffs	722.62	614.02	688.62	648.02
Yawls	865.84	111.65	376.21	601.28
Tools and appliances	1,640.83	1,616.75	1,283.53	1,974.05
Boarding outfit	12,377.40	523.00	1,844.99	11,055.41
Office furniture	506.75		96.28	410.47
Survey instruments	616.31	95.00	137.10	574.21
Photographic apparatus	222.75		22.27	200.48

[illegible]	91.18	340.0[illegible]
s	164.81	448.0[illegible]
, screws	166.54	659.1[illegible]
, assorted	19	8[illegible]
ses	141.45	4.1[illegible]
ber	371.53	780.4[illegible]
m	25.82	242.9[illegible]
	253.60	6,033.9[illegible]
		892.8[illegible]
hers	7.51	
rial, miscellaneous	514.94	1,127.0[illegible]
istence	138.37	15,791.2[illegible]
ky and cinchona	1,399.63	22.90
Mignon	4,077.72	
property	42,625.03	
t and loss	24,555.19	47.47
Total	245,500.92	112,330.96

PULLTIGHT.

Labor, material, equipment, etc.	Piling (1,979 piles driven, 30,669 feet).	Stringing (532 stringers).	Bracing (706 braces).
r, superintendence, etc	$3,690.95	$1,813.32	$2,185.60
ral expense			
d States engineer office			
o readers			
hone			
ner *Gillmore*	266.07	159.64	124.16
s			
flats	10.65	5.09	7.18
rivers	1,675.59	854.18	860.00
r-boats			
ers	42.10	17.94	21.77
y depot			
	361.23	140.29	213.39
	163.72	62.72	77.88
	12.36	21.15	31.82
and appliances	132.61	62.67	78.20
g outfit			
nce			
y and cinchona			
re			
instruments			

PULLTIGHT—continued.

, material, equipment, etc.	Revetment (1,925 linear feet, 102,650 square feet).	Subsistence.	Supervision.	Contingencies.	Total.
intendence, etc	$ 68.06	$2,131.21	$1,510.91	$66.53	$17,463.53
ense			3,245.47		3,245.47
e engineer office			4,217.58		4,217.58
rs				125.33	125.33
				1,030.55	1,030.55
more	176.32	334.07			1,739.74
		996.82			1,460.61
		30.72	75.03		151.36
					3,657.73
s		526.84			526.84
	1.47	1,064.04	249.43		1,457.21
t				190.50	190.50
	182.05				1,504.06
	11.53		36.73		422.86
	1.93				181.08
pliances	48.80				652.83
tfit		991.51			991.51
		7,851.34			7,851.34
cinchona				6.45	6.45
			1[illegible].31	34.20	46.51
uments			61.60		61.60
					11,009.81
					13,698.23
	3,524.60				7,290.30
					401.64
					424.11
					204.84
					131.40
					179.00
					368.35
					22.65
					44.00
		110.64	5.91		610.87
		283.85			283.85
					4.12
s material	2.00	59.68	7.02		155.90
	.20				.20
					.78
	4,516.96	14,381.32	9,422.59	1,453.56	81,875.34

JIM SMITH'S.

rial, equipment, etc.	Mattress (1,775 linear feet, 213,000 square feet).	Revetment (1,675 linear feet, 65,425 square feet).	Subsistence.	Supervision.	Contingencies.	Total.
rintendence, etc	$1,585.08	$718.10	$269.33	$485.57	$206.85	$3,264.93
ense				828.86		828.86
es engineer office				1,596.06		1,596.06
ers					49.33	49.33
					355.38	355.38
llmore	147.34	11.33	56.67			215.34
	348.49		371.45			719.94
			32.86	32.86		65.72
	473.54					473.54
ts			17.28			17.28
			464.71	113.83		578.54
	97.45	71.21				168.66
	17.26	5.94		6.44		29.64
	83.23	1.53				84.76
	128.15	46.12				174.27
ntfit			294.61			294.61
			987.82			987.82
				17.70		17.70
ruments				30.00		30.00
	4,514.12					4,514.12
	236.84					236.84
	862.53	2,772.49				3,645.02
e	108.00					108.00
	23.80					23.80
	95.03					95.03

SULPHUR SPRINGS.

abor, material, quipment, etc.	Piling (523 piles driven, 8,871 feet).	Stringing (165 stringers).	Bracing (93 braces).	Mattress (1,874 linear feet, 126,260 square feet).	Wattling (3,660 linear feet, 50,179 square feet).	Revetment (225 linear feet, 3,500 square feet).	Subsistence.	
ıbor, superin-endence, etc	$762.84	$509.82	$155.74	$1,101.11	$1,155.65	$23.55	$004.00	[illegible]
ıneral expense								1
ıited States ıngineer office								1,
ıuge readers								
lephone								
ıamer *Gillmore*	257.20	79.82	44.34	150.77	276.43	8.87	242.92	
rges							550.80	
rge flats							41.41	
e-drivers	369.20	202.44	85.93					
arters							625.09	
ıply depot								
ts	48.00	32.68	12.77	126.61	1,002.44		11.75	
ffs	7.18	2.45	.87	26.28	26.01			
vls	21.92	12.74	5.14	15.41	55.16			
ls and appli-ices	27.95	15.83	3.78	52.26	77.80	1.32	3.24	
rding outfit							415.83	
aiture								
ıy instru-ıts								
tence							1,828.43	
ky and cin-ma								
				2,039.58	743.90			
	2,245.85	613.23	384.43					
				1,090.07	63.15	112.60		
a rope	144.00	24.00	12.00	108.00				
ope	9.80	5.34	2.45	73.50	53.93			
				59.27	18.35			
				22.50	6.18			
	10.92			26.52				

A.—*Record of gauge at Grafton, Ill., for fiscal year ending June* 30, 1888.

[Height of water above plane 200 feet below Saint Louis city directrix.]

uly.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
.47	191.88	191.69	193.22	192.30	190.49	193.29	196.54	198.36	205.05	206.03	196.23
.61	191.83	191.66	193.13	192.29	190.47	193.64	196.47	198.12	204.68	206.42	195.86
.67	191.76	191.62	193.02	192.27	190.68	193.88	196.37	198.36	204.10	206.72	212.00
.72	191.64	191.53	192.94	192.24	190.81	193.87	196.64	199.27	203.68	207.02	211.68
.76	191.08	191.46	192.83	192.22	191.04	193.80	196.68	199.62	203.26	207.32	211.37
.74	191.63	191.42	192.74	192.18	191.50	194.72	197.02	199.52	202.87	207.48	210.68
.62	191.58	191.36	192.69	192.10	191.72	195.58	196.62	199.27	202.66	207.64	210.02
.52	191.52	191.47	192.64	192.03	191.75	196.12	196.34	199.32	202.52	207.73	209.62
.44	191.46	191.57	192.65	191.98	191.62	196.65	195.95	199.57	202.68	208.06	209.07
.33	191.42	191.73	192.75	191.98	191.60	196.98	195.49	199.95	202.77	208.13	208.68
.22	191.35	191.91	192.77	191.95	191.59	196.45	195.02	200.47	202.84	208.31	208.22
.86	191.32	191.99	192.78	191.95	191.72	196.02	194.82	200.64	202.84	208.52	208.67
.63	191.26	192.06	192.77	191.94	191.78	195.82	194.92	200.82	203.52	208.66	207.28
.42	191.24	192.07	192.72	191.94	191.84	195.81	195.02	200.72	204.07	209.87	206.92
.24	191.28	192.17	192.66	191.92	191.88	195.79	195.06	200.52	204.52	209.22	206.91
.02	191.36	192.46	192.57	191.87	191.86	195.79	195.12	200.64	204.78	209.47	207.07
.78	191.67	192.64	192.48	191.87	191.48	195.78	195.12	201.33	204.87	209.72	206.87
2.67	191.88	192.86	192.46	191.84	191.47	195.77	195.22	201.49	204.92	210.22	206.62
2.53	191.96	193.34	192.41	191.81	191.51	195.74	195.52	201.65	204.86	210.57	206.21
2.46	191.90	193.56	192.37	191.78	191.67	195.72	195.92	201.52	204.78	210.86	205.82
2.47	191.83	193.64	192.37	191.75	191.56	195.68	196.77	201.58	204.70	211.18	205.22
2.61	191.76	193.68	192.37	191.72	191.50	195.63	197.12	201.72	204.63	211.72	205.53
2.64	191.72	193.68	192.38	191.70	191.32	195.52	197.14	202.82	204.52	212.17	205.92
2.60	191.68	193.64	192.39	191.70	191.02	195.42	198.07	203.28	204.63	212.47	206.02
2.55	191.63	193.62	192.41	191.76	190.63	195.30	199.12	203.46	204.71	212.57	205.87
2.46	191.58	193.56	192.42	191.84	190.32	195.17	199.16	204.51	204.54	212.48	205.78
2.42	191.61	193.47	192.39	191.85	190.22	195.03	199.18	206.06	204.68	212.37	205.78
2.31	191.68	193.52	192.35	191.68	190.12	194.92	199.12	206.53	205.02	212.48	205.80
2.20	191.80	193.42	192.32	191.32	190.12	195.14	198.58	206.52	205.33	212.57	205.76
2.12	191.72	193.34	192.32	190.92	191.80	195.62	.....	206.12	205.72	212.58	205.67
1.98	191.63	.....	192.30	.....	192.73	195.92	.....	205.66	.....	212.56	.....

—*Record of gauge at Gray's Point, Mo., for fiscal year ending June* 30, 1888.

[Height of water above plane 200 feet below Saint Louis city directrix.]

August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
98.41	95.21	96.76	93.91	93.76	88.66	100.71	105.16	113.76	108.56	115.51
98.06	95.11	96.71	93.86	93.46	88.36	99.11	104.36	113.06	108.76	115.66
97.81	95.16	96.56	93.81	93.16	88.26	99.21	103.66	112.11	108.76	115.61
91.61	95.16	96.46	93.76	92.86	88.16	100.16	103.16	111.26	109.06	115.61
97.51	94.96	96.31	93.76	93.46	89.36	102.61	102.86	110.56	109.46	115.91
97.46	94.86	96.11	93.71	93.66	91.06	101.66	103.66	110.01	109.76	115.61
97.31	94.76	95.91	93.66	93.91	91.66	101.56	104.41	109.06	109.91	114.96
97.11	94.66	95.61	93.61	94.66	92.86	101.66	104.61	108.56	110.11	114.16
96.86	94.66	95.46	93.56	95.36	92.66	100.96	104.26	108.26	110.21	113.36
96.66	94.81	95.31	93.46	96.31	93.46	99.96	103.96	109.36	110.26	113.16
96.51	95.56	95.21	93.41	96.51	95.66	99.16	103.76	110.36	110.56	111.96
96.46	96.61	95.11	93.36	96.26	96.21	97.66	103.76	110.06	111.06	111.56
96.46	97.01	95.06	93.36	95.26	96.06	96.36	104.06	109.81	111.56	110.81
96.36	97.01	95.01	93.26	94.56	95.41	96.06	104.26	110.16	111.76	110.36
96.11	96.76	95.61	93.26	93.96	94.86	95.61	104.16	110.76	112.16	109.66
95.96	96.51	96.21	93.26	93.56	95.41	95.36	104.06	111.16	112.66	109.66
95.86	96.51	96.21	93.21	93.31	98.06	95.26	103.86	111.06	112.91	110.66
95.96	96.56	95.66	93.26	93.11	98.26	95.26	103.91	110.76	113.16	111.11
96.06	97.76	95.21	93.26	92.66	98.56	95.26	104.31	110.36	113.41	112.26
96.01	99.66	94.86	93.26	92.46	99.16	95.66	104.61	109.86	113.91	112.66
95.91	99.76	94.66	93.31	92.46	99.01	96.41	104.71	109.46	113.96	112.36
95.76	99.61	94.51	93.26	92.11	98.76	97.36	105.56	109.46	113.86	111.76
95.61	98.96	94.36	93.26	91.71	99.06	99.36	105.66	109.51	114.16	111.06
95.41	98.51	94.21	93.36	90.96	99.66	101.01	106.86	110.16	114.46	111.46
95.26	98.06	94.16	93.36	89.96	99.96	104.66	108.96	110.51	114.66	111.76
95.26	97.71	94.11	93.26	89.46	100.16	105.86	110.06	110.36	114.46	112.06
95.41	97.46	94.06	93.56	89.41	100.36	106.16	112.26	109.81	114.11	112.26
95.51	97.16	94.06	94.11	89.01	100.56	105.66	114.26	109.11	114.06	112.21
95.46	96.96	93.96	94.11	87.06	100.46	105.51	114.96	108.76	114.06	112.11
95.41	96.86	93.91	93.96	87.06	100.51	.....	114.76	108.46	114.51	112.41
95.31	.....	93.96	.....	87.06	101.36	.....	114.36	.....	114.96	.....

88——91

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo.*

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Twin Hollows.	Bulltight.	Golden Gate.	Rattle Snake.	Fine's Bluff.	Jim Smith's.	Sulphur Springs.	Lucas.	Cornice Island.	Platin Rock.	Atlantic.	Selma.	Kennett's.	Forest Home.	Perry's Tow-head.	Cambria Hollow.	Brickley's.	Fort Chartres.	Dickey Field.	Turkey Island.	Little Rock.	Ste. Genevieve.	Ste. Genevieve Bend.	Saline Creek.	Saint Mary's.	Block's.	Mary Island.
1887.	*Feet.*																																
July 3	12.60	Jay Gould	Down						18				10½		15						10½								12	10½			
July 7	12.80	General Gillmore		17	18	16½	13½					14	13½																				
July 10	12.10	City of Vicksburg	Down				10½			12				12	15					10½	12								12				
July 10	12.10	City of New Orleans	Down					12					13½		18				15		12								13½		12		
July 15	9.70	Belle Memphis	Down																														
July 16	9.30	City of Providence	Down				8½						6½	12						8	8								10½			9	
July 16	9.30	City of Saint Louis	Down				8½						7	10½	18			9½			10½								9½			9	
July 20	7.80	Arkansas City	Down				7½						7	9	12					9	7	10½							9			10½	
July 22	7.40	City of Vicksburg	Down				7						9	9	13½					8½	8								9			10½	
July 22	7.40	Port Eads	Down	12			6½					16½	8	8½	13½					8	8	9		9			10½	16½	8			9½	
July 23	7.40	City of Cairo	Down				6½						7½	9						8½	7½								7			9	
July 27	7.40	Belle Memphis	Down				7						7½	9	10½					9									8			9	
July 29	6.90	City of Providence	Down				6						8	9						8	8			10½					12			9	
July 30	6.50	Arkansas City	Down				5½				9		8		10½			9			7							9½	7½			9	
July 30	6.50	T. B. Sims	Down				6		9½				9	10½						9	6½								7				
July 30	6.50	Future City	Down				7																										
Aug. 1	5.80	City of New Orleans	Down				7½						9	8	13½					7½	6½			10½					8			9	
Aug. 3	5.50	City of Vicksburg	Down				8			8	8	9		8						8	6½			7½					8			7½	
Aug. 6	5.00	Belle Memphis	Down						10½				8	7	10½			8			5½			7½			9	9	7			7½	
Aug. 9	4.60	City of Providence	Down				6						7	6						6	6			7			9		6			8	
Aug. 13	4.00	Arkansas City	Down				7				10½		10½		10½			7½				8			8		8		6				
Aug. 14	3.90	City of Vicksburg	Down				7						7	7				7											6				
Aug. 15	3.80	City of Baton Rouge	Down	8½			6½		8½				9½								8				8½	7½	6½	8	7½			8½	
Aug. 16	3.60	City of Cairo	Down	8			7				9		8½	7½			9½			7	7		7½	6½			7½	12	5½			8½	
Aug. 21	3.60	City of Providence	Down	7½			6						9	5½		15				5½	8			6½			8						7½
Aug. 24	3.30	Arkansas City	Down				6½							6½	10½						7			6			7					8	
Aug. 26	3.50	City of Vicksburg	Down																														
Aug. 27	3.50	City of Saint Louis	Down	8			7						9	7							9			8					7			7	
Aug. 27	3.50	City of Cairo	Down	7			7						8½	5½	9					6	6½		7	7			7	9	6			6½	

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction up or down.	Allen's.	Manscoe's.	Liberty Island.	Ryan's.	Bailey's.	Apple Creek.	'76 Crossing.	Crawford's.	Hanging Dog Island.	Neeley's.	Vancil's.	Bainbridge.	Kinney Point.	Devil's Island.	Cape Girardeau Bend.	Jacket Pattern.	Burnam's.	Atherton's.	Goose Island.	Commercial Point.	Price's Landing.	Hacker's Bend.	Dog Tooth Island.	Orient.	Thompson's.	Pond Lily.	Greenleaf's.	Eliza Point.	Chase's.	Mouth of Ohio.
1887.	*Feet*																																
July 3	12.60	Jay Gould	Down		12				12								13½		12									9					
July 7	12.80	General Gillmore																															
July 10	12.10	City of Vicksburg	Down						15							12												8					
July 10	12.10	City of New Orleans	Down		15											10½			13½			13½						8½		10½			
July 15	9.70	Belle Memphis	Down																					7				7		9			
July 16	9.30	City of Providence	Down		13½				10½							8½						12						8		10½		12	
July 16	9.30	City of Saint Louis	Down	12			9		10½							8½			9									7½		10½			
July 20	7.80	Arkansas City	Down		10½	9	10½		9							7½												7		7			
July 22	7.40	City of Vicksburg	Down	9		8½	8		8½							7			10½			10½						6½		8			
July 22	7.40	Port Eads	Down		9	9	8		7	10½	9		12	12	8½		7		9½			9			12	10½		6½	15	6½	8		
July 23	7.40	City of Cairo	Down		8	10½	9		9							6½			9			9						6		9			
July 27	7.40	Belle Memphis	Down			9	8		9							6½			10½	10½							9½						
July 29	6.90	City of Providence	Down		8	10½	7		8			12				6½			10½			10½						8		10½			
July 30	6.50	Arkansas City	Down		8	9	9		6½			9				6½			9									6½		7½			
July 30	6.50	T. B. Sims	Down		10½	9½		10½	8½							7												8½					
July 30	6.50	Future City	Down		6		6									6																	
Aug. 1	5.80	City of New Orleans	Down	8			8		9		9		9			6½				7½		8½		9½			12	8½		10½			
Aug. 3	5.50	City of Vicksburg	Down	8		8	7½		6							6½			8									8		10½			
Aug. 6	5.00	Belle Memphis	Down		7	9½	7		6							7			8			9	9		10½		10½	8½		8½			9
Aug. 9	4.60	City of Providence	Down		7	8	6		6							6½	8½		7			8						7					
Aug. 13	4.00	Arkansas City	Down			7			6							5½																	
Aug. 14	3.90	City of Vicksburg	Down	7½		8	8		6							6			6½									6½		8			
Aug. 15	3.80	City of Baton Rouge	Down	6½		8½	9		7							5½		8½	8½			9½	7		9		8½	7½		9			
Aug. 16	3.60	City of Cairo	Down		7	7½	8		6			7				6	8½	6½	7½		9		7½		8½		8½	5½		8			9
Aug. 21	3.60	City of Providence	Down				8½		6			7				6			7			8								9			
Aug. 24	3.30	Arkansas City	Down			8	8		6		7	9				6			8			7½	5½	9			8	7		8			
Aug. 26	3.50	City of Vicksburg	Down	6½		6½	7		6							6½			7			8			10½								
Aug. 27	3.50	City of Saint Louis	Down		7	7½	9		6						7	7	7½	8	7½		9		7		9	9	9	7½		7½			
Aug. 27	3.50	City of Cairo	Down		6	7	10½		6½			6½			7	6½		7½	7½				7				6½	6		9			

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Quarantine.	Twin Hollows.	Fine's Bluff.	Chesley Island.	Sulphur Springs.	Bridgewater.	Lucas.	Cornice Island.	Atlantic.	Selma.	Forest Home.	Perry's Tow-head.	Fish Bend.	Sycamore.	Brickey's.	Cambria Hollow.	Crook's.	Dickey Field.	Fort Chartres.	Fort Chartres.	Turkey Island.	Lime Kiln.	Little Rock.	Ste Genevieve.	Ste Genevieve Bend.	Block's.	Allen's Landing.	Water's.
1887.	*Feet.*																																	
Sept. 4	2.90	Arkansas City	Down	9		8	6			10½		6	10½	10½	7½		7			7				6			7		8	7	7		
Sept. 9	3.20	General Gillmore		10½	12	9	6½	11	12	9½																							
Sept. 10	4.40	Belle Memphis	Down									12																					
Sept. 12	4.90	City of Cairo	Down																														
Sept. 14	4.50	City of Providence	Down									12			8															8			
Sept. 16	4.50	General Gillmore		12	13½	9½	7½	11	12	12																							
Sept. 16	4.50	Arkansas City	Down				8					10½				7				8				7						7			
Sept. 24	5.50	General Gillmore		12	14	10½	9½	13	12	10½																							
Sept. 25	5.30	T. B. Sims	Down				7½			10½		9				9	10½						10½	10½	10½			10½		10½			
Sept. 26	4.80	City of Saint Louis	Down				8			9		12				9	9							9									
Sept. 29	4.60	General Gillmore		12	13½	9½	8½	12	12	10½																							
Sept. 30	4.60	Arkansas City	Down				6½			9							8																
Oct. 5	3.70	W. S. Hays	Down				6			9						8	9							7½				8		9	9		7½
Oct. 6	3.50	City of Cairo	Down				6½			9		10½				8½	8			7				6	7½		6½			10½	9		
Oct. 8	3.10	General Gillmore		10½	11	9	6	10½	11	9½																							
Oct. 8	3.10	Belle Memphis	Down				7½			9					7½		8½							9	8½					12	7		
Oct. 12	2.90	City of Providence	Down				5½									8				6½				6						7	7		
Oct. 13	3.10	Arkansas City	Down				6									8							8	6	6½		7				8		
Oct. 13	3.10	Annie P. Silver	Down				5½			8½		8½				7½	7		7½	5							5½			7½			
Oct. 13	3.10	General Gillmore		10½	10½	8½	6	10½	10½	8½																							
Oct. 16	3.50	Paris C. Brown	Down				7			9		8				7	8				7			8				7		8	8		
Oct. 16	3.50	City of Vicksburg	Down				6									8	9							5½			5½			10½	8	6	
Oct. 17	3.10	General Gillmore			10½	9	6½	9	10½	8½		9				8	8																
Oct. 20	2.50	Commonwealth	Down				5½				8				7		7			7				5½	5½					7			6½
Oct. 21	2.20	Future City	Down																							8							
Oct. 21	2.20	City of Cairo	Down				6			7		9		12		6½	7			6½				5½			5½		8	7½	6½		
Oct. 22	2.00	Belle Memphis	Down				6					8				6½						6		5½	7½	8				7	7		
Oct. 22	2.00	City of Saint Louis	Down				6					7				6½	7							5½	6½	7½				6½			
Oct. 26	1.80	City of Providence	Down				5	8		7		9				7	7							5½	6	8				6	7		
Oct. 26	1.80	General Gillmore		9	10½	7½	6	9	10½	9		7	7			6½	6	9															
Oct. 28	1.80	Arkansas City	Down				7	7		6½		7			6		6					5½	6	4½		8				6	6		
Oct. 31	1.70	City of Vicksburg	Down				6			6½		6				6								5	5	7				6			
Oct. 31	1.70	General Gillmore		9	9½	7	8	9	9½	9		8																					

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Mansoce's.	Liberty Island.	Sheep Island.	Ryan's.	Bailey's Landing.	Apple Creek.	Crawford's Landing.	Oliver's.	Hanging Dog Island.	Bainbridge.	Kinney Point.	Devil's Island.	Cape Girardeau Bend.	Jacket Pattern.	Commerce.	Atherton's Landing.	Goose Island.	Commercial Point.	Price's Landing.	Hacker's Bend.	Buffalo Island.	Dog Tooth Island.	Orient.	Thompson's Landing.	Mo. Sister's Island.	Greenleaf's.	Pond Lily.	Chase's.	Incline.	Mouth of Ohio.
1887.	*Feet.*																																
Sept. 4	2.90	Arkansas City	Down	7	7		8		6		5½			6½	8	8	6½			6	7						6						
Sept. 9	3.20	General Gillmore																															
Sept. 10	4.40	Belle Memphis	Down								6																6						
Sept. 12	4.90	City of Cairo	Down							8½		7																					
Sept. 14	4.50	City of Providence	Down							9				7½													8		9		10½		
Sept. 16	4.50	General Gillmore																															
Sept. 16	4.50	Arkansas City	Down	7					7			9		7½													8		8½				
Sept. 24	5.50	General Gillmore								12																							
Sept. 25	5.30	T. B. Sims	Down	9	10½		10½		9½				9																				
Sept. 26	4.80	City of Saint Louis	Down		9			10½	8½					8													8½		8½				
Sept. 29	4.60	General Gillmore																															
Sept. 30	4.60	Arkansas City	Down							9				6½													8		9				
Oct. 5	3.70	W. S. Hays	Down		7½				7½	9				7			9		9		9		8			6½		8		10½		9	
Oct. 6	3.50	City of Cairo	Down	6½	8½		9		6½	9½		10½		6½			7½	6½	7½	9	9		12			7½	7		7			9	
Oct. 8	3.10	General Gillmore																															
Oct. 8	3.10	Belle Memphis	Down	5½	7½		8		6½	9				5½	7		7			8½	9					6½	6½					10½	16½
Oct. 12	2.90	City of Providence	Down	6	7				6					6							8						6		7				
Oct. 13	3.10	Arkansas City	Down	6					6					6			7			7	8					6	6½		7				
Oct. 13	3.10	Annie P. Silver	Down	6½		7½		9½	6	8½		9½		6	9½	7½	7		8		7½	9		8½	6		6		7				
Oct. 13	3.10	General Gillmore																															
Oct. 16	3.50	Paris C. Brown	Down	7	9			8	6					6						7	8					8	8		8				
Oct. 16	3.50	City of Vicksburg	Down		9		8		7	10½				7																			
Oct. 17	3.10	General Gillmore																															
Oct. 20	2.50	Commonwealth	Down		7		7		6	8				5½			7						6½			6½	6		6				
Oct. 21	2.20	Future City	Down																														
Oct. 21	2.20	City of Cairo	Down	5½	6½		8		5½	8½		7	6	5	9		6½		6½	8	7	9	7			6½	5½		7	9½		9	
Oct. 22	2.00	Belle Memphis	Down	7	6		7		5½					5½					6		8					5½	6		6				
Oct. 22	2.00	City of Saint Louis	Down	6	7		7		6					5½					6		7		7			6	7		6½		10½		
Oct. 26	1.80	City of Providence	Down	5½	6		5½		6					5½			7			7	7					5½	6½		5½				
Oct. 26	1.80	General Gillmore																															
Oct. 28	1.80	Arkansas City	Down	5½			7		6					4½												6	7						
Oct. 31	1.70	City of Vicksburg	Down	5					5½					5			6				7						7						
Oct. 31	1.70	General Gillmore																															

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo.*

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Quarantine.	Pulltight.	Twin Hollows.	Fine's Bluff.	Meramec River.	Chesley Island.	Sulphur Springs.	Lucas.	Harrisonville.	Atlantic.	Cornice Island.	Selma.	Forest Home.	Osborne Field.	Perry's Towhead.	Brickeys.	Fish Bend.	Dickey Field.	Crook's.	Establishment.	Fort Chartres (head).	Fort Chartres (foot).	Little Rock.	Turkey Island.	Ste. Genevieve Island.	Ste. Genevieve Bend.	Kaskaskia.	Mary River.
1887.	*Feet.*																																
Nov. 2	1.50	Gen. Gillmore		9	9½	7½		7½	9		9½	9	8			7½		7		6½						5½		6½	6	7	6½		
Nov. 4	1.50	City of Cairo	Down			5½		6				6½	8½					6		6½	7					5½			8	9	5½		
Nov. 12	1.10	City of Providence	Down					6½	10½			7	9					6½		7						6	5		9		5		
Nov. 12	1.10	Gen. Gillmore		8½	9½	8		6½	8		8½	7½																					
Nov. 15	1.10	do		8½	9½	7½		7	8		8½	8																					
Nov. 17	1.00	Ivy	Up																														
Nov. 27	1.40	Gen. Gillmore		9½	10½	8½		7	8½		8½	9	7			8		6		8½		9				7			6½	8	7½		
Dec. 2	−.50	Commonwealth	Down				5					6					5½			4	5					5					5½		
Dec. 3	−.70	War Eagle	Down				5½		5½			9	8					6		5½			6			5½	5½		7		9		
Dec. 10	3.30	City of Cairo	Down					9½	12			10½	9					9		7						9	8				10½		
Dec. 12	2.00	Oakland	Up					8	8	12		10½		9				8½							5	7½			6½				6
Dec. 12	2.00	Annie P. Silver	Down					8½	9			8½	9							7½				6½		7			10½		12		
Dec. 13	1.50	Arkansas City	Down	7½		7		7	6			9	8					6	7	6						9	6		7		5½	9	
Dec. 17	0.40	St. Paul	Down			5½		6½	7			9	7					6		5						5½					5		
Dec. 19	−0.20	Paris C. Brown	Down																														
1888.																																	
Feb. 5	9.50	City of St. Louis	Down			18		16½										12		12													
Feb. 14	3.20	(Not stated)	Up			12		9	12				12		13½			12		10½						10½	9		5½				
Feb. 18	2.90	Arkansas City	Down	9		9	10½	9	7				9					9		9			8			8	9						
Feb. 20	3.60	Annie P. Silver	Down	12				10½	7½	9		12						10½		8			9			9	9		12		8		
Feb. 21	4.80	Jay Gould	Up																														
Feb. 22	6.00	City of New Orleans	Down	12		12		12	12								13½			8½						13½					12		
Feb. 24	9.00	Belle Memphis	Down																												10½		
Mar. 2	9.00	City of Monroe	Down			13½		18									18			18											18		
Mar. 3	8.40	Arkansas City	Down			15			10½																								
Mar. 10	10.10	Baton Rouge	Down			16½				16½																							
Mar. 18	11.50	Port Eads	Down	16½			12	8		10½		22½	12		16½			10½		15	13½										12		
Mar. 25	16.00	Future City	Down	19½			18	13½		15			18					12		19½			19½			15					16½		
Apr. 6	15.30	Gen. Gillmore						15										16½		22½													
Apr. 9	17.40	do			28			18			18	16½	18					18															
Apr. 10	18.10	City of Monroe	Down	21			18			18			21					21															
Apr. 11	17.50	City of St. Louis	Down	18				13½					18					10½					16½										18
Apr. 13	18.20	Gen. Gillmore											19½					18		18						15			18				
Apr. 17	18.40	do			28							18	18							18													
Apr. 23	18.90	do			28						18	24																					

B.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Blocks.	Manscoe's.	Water's.	Liberty Island.	Ryan's.	Bailey's Landing.	Price's Landing.	Apple Creek.	Crawfork's Landing.	Hanging Dog Island.	Bainbridge.	Kinney Point.	Devil's Island.	Cape Girardeau Bend.	Jacket Pattern.	Commerce.	Atherton's Landing.	Goose Island.	Commercial Point.	Hacker's Bend.	Buffalo Island.	Dog Tooth Island.	Orient.	Thompson's Landing.	Missouri Sisters Isl'd.	Greenleaf's.	Incline.	Bird's Point.	Mouth of Ohio.
1887.	*Feet.*																															
Nov. 4	1.50	City of Cairo	Down.	6	5	....	6	7	....	6½	....	....	....	6	5¼	....	....	5½	5½	6	6	....	....	....	....	6	5½	....	5	....	....	....
Nov. 12	1.10	City of Providence	Down	7	6	....	5½	....	....	7	5½	....	7½	5½	4½	....	6	....	....	....	....	6½	....	....	....	5	6	....	5½	6	....	....
Nov. 17	1.00	Ivy	Up	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	8	....	....	7	....	....
Dec. 2	—.50	Commonwealth	Down.	....	5	....	6	....	....	....	5	....	....	....	4½	....	....	5½	....	....	6	....	....	....	....	5	6	....	5	....	....	....
Dec. 3	—.50	War Eagle	Down.	6	6	....	6	6	....	....	5	....	....	8	5	9	6½	6	....	5½	....	7	....	6½	7	6	6	....	5½	....	6	12
Dec. 10	3.30	City of Cairo	Down.	8	7	....	8	....	....	6½	6	....	....	....	7	....	....	8	....	....	7	6	....	9	....	....	9	....	8	....	....	....
Dec. 12	2.00	Oakland	Up	....	8	....	7½	....	....	....	....	9	9	....	5½	....	6	....	....	....	....	7½	7	....	....	6	....	6	5½	....	....	7½
Dec. 12	2.00	Annie P. Silver	Down.	7½	....	8	7	....	7½	....	7½	9½	9½	10½	7½	....	....	7½	....	....	....	7½	....	....	....	7½	....	....	7½	....	....	....
Dec. 13	1.50	Arkansas City	Down.	6	....	6	6	6	....	....	5½	....	....	....	6	....	7	6	....	....	6½	5	....	7	....	6	8	....	6	....	....	....
Dec. 17	0.40	St. Paul	Down.	....	5	....	5½	....	....	....	5	....	....	....	5	....	....	....	....	....	4½	....	5½	....	....	5½	6	....	4½	....	....	....
Dec. 19	—.20	Paris C. Brown	Down.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	....	....	....
1888.																																
Feb. 5	9.50	City of St. Louis	Down.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	13	9	12	....	....	....
Feb. 18	2.90	Arkansas City	Down.	8	6½	....	8	....	8	....	8	8	8	....	7½	....	....	8	....	....	6½	6½	6½	....	....	8	9	....	9	....	....	....
Feb. 20	3.60	Annie P. Silver	Down.	9	8	....	9	9	....	....	8	12	9	12	8	10½	10½	....	....	8	7½	8	9	....	....	9	....	....	10½	....	....	....
Feb. 21	4.80	Jay Gould	Up	10½	9	....	12	10½	....	....	9	8	....	9	....	....	....	9	....	....	7	6	8	....	....	9	9	....	8½	....	....	....
Feb. 22	6.00	City of New Orleans	Down.	....	12	....	13½	12	....	....	....	....	....	....	13½	....	....	15	....	11	....	12	13½	....	....	12	13½	....	13½	....	....	....
Feb. 24	9.00	Belle Memphis	Down.	....	....	....	....	12	....	....	....	....	....	....	....	....	....	....	....	7	....	9	....	....	....	....	12	....	....	....	....	....
Mar. 2	9.00	City of Monroe	Down.	....	12	....	18	....	....	....	....	....	....	....	16½	....	....	....	....	....	15	....	....	....	....	15	18	....	18	....	....	....
Mar. 3	8.40	Arkansas City	Down.	....	10½	....	....	....	15	....	....	....	15	....	....	....	....	....	....	....	10½	....	....	....	....	....	18	....	....	....	....	....
Mar. 10	10.10	Baton Rouge	Down.	....	....	....	....	....	....	....	....	....	....	....	13½	....	....	....	....	12	....	13½	....	....	....	....	16½	....	....	....	....	....
Mar. 18	11.50	Port Eads	Down.	12	15	....	13½	....	....	....	15	12	....	13½	10½	....	....	12	....	10½	....	10½	13½	....	13½	15	15	....	13½	....	....	....
Mar. 25	16.00	Future City	Down.	12	16½	....	13½	17½	....	....	....	....	....	19½	13½	18	....	18	....	....	13½	18	16½	....	....	19½	16½	....	16½	....	....	....
Apr. 10	18.10	City of Monroe	Down.	16½	....	....	....	....	....	....	....	....	....	....	....	21	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Apr. 11	17.50	City of St. Louis	Down.	....	....	....	....	....	....	....	....	....	....	....	....	18	....	....	....	....	13½	....	....	....	....	....	....	....	....	....	....	....

W 3.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The improvement of this stream has consisted in the removal of obstructions to navigation in the shape of leaning timber, snags, stumps, etc., and the construction of low wing-dams to facilitate the passage of boats over the shoals during low water.

The work was begun in 1880, and has been continued, when funds were available, up to the present time.

Work was begun for the fiscal year ending June 30, 1888, on September 13, 1887, and consisted in the construction of dams or training-walls at Round Island and Bock's Bar, and in the removal of all obstructions in the shape of snags of which complaint has been made. The work was continued in the fall until November 21, when the working party was disbanded and the plant stored at Hermann, Mo.

The amount of work done was as follows: Six hundred and thirteen linear feet of dam or training-wall, with an average height of 3 feet, was constructed at Round Island, and 330 linear feet of dam or training-wall, with an average height of 3 feet, was constructed at Bock's Bar. The average cost of the work was $1.14 per linear foot. For the details of the work I would refer to the report of my assistant, Mr. J. W. Beaman, which is forwarded herewith.

The river is now in a fairly good navigable condition from Arlington to its mouth.

The work has been of benefit to the navigation of the river, especially to the rafting interests, which are quite large.

With the amount recommended to be appropriated for the fiscal year ending June 30, 1890, it is proposed to continue the removal of obstructions and to close some of the side chutes, in order to concentrate the water in the main channel of the river.

The estimated cost of this improvement was $50,000.

The former appropriations are:

By act of—	
June 14, 1880	$5.000
March 3, 1881	10,000
August 2, 1882	10,000
July 5, 1884	5,000
August 5, 1886	7,500

Money statement.

July 1, 1887, amount available	$3,075.61
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,013.64
July 1, 1888, balance available	61.97
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,061.97
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

Articles.	Quantity.	Value.
Shipments down the river.		
Wheat	57,212 bushels, at 80 cents	$45,769 60
Corn	125 bushels, at 50 cents	62.50
Barley	54 bushels, at 60 cents	32.40
Walnut lumber	5,400 feet, at 6 cents	324.00
Hay	116 bales, at $1	116.00
Live hogs	135 head, at $12.50	1,687.50
Cord-wood	617½ cords, at $2	1,235.00
General merchandise	28 tons	714.00
Yellow-pine lumber	1,000,000 feet, at 1.2 cents	12,000.00
Railway-ties	500,000, at 33⅓ cents	166,666.67
Total		228,607.67
Shipments up the river.		
Pine lumber	1,150 feet	45.00
Flour	191 sacks, at $2.20	420.20
Salt	59 barrels, at $1.65	97.35
Nails	55 kegs, at $3	165.00
Farm machinery		365.00
General merchandise	8.3 tons	1,168.85
Total		2,261.40
Total value of river commerce		230,869.07

This statement shows an increase in the value of down-stream shipments. This increase is covered by the wheat and railway-ties items.

Last year's report showed shipments of 42,776 bushels of wheat at 65 cents, worth $27,804.40; this year's statement shows an increase of 14,436 bushels, and an increase of total value of $17,965.20.

Last year's report showed shipments of 454,000 railway-ties, at 33⅓ cents, worth $151,333.33; this year's statement shows an increase of 46,000 ties, and an increase of total value of $15,333.34.

The number of ties is given in a round estimate, but this is practically correct.

The up-river shipments this past year were somewhat less than one-half what were reported one year ago; they were inconsiderable both years.

The total increase in value of the past year's commerce over that of the previous year was $27,861.44.

The total number of tons of freight carried by steamboat was 2,817; this includes all commerce except railway-ties and yellow-pine lumber, which were rafted.

The steam-boats engaged in river commerce were as follows:

Name.	Draught.	Burden.
	Inches.	*Tons.*
Royal	14	78
Vienna	13	75
Farm	14	70

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

HERMANN, MO., *June* 30, 1888.

SIR: I have the honor to make the following report upon the improvement of the Gasconade River, Missouri, for the fiscal year ending June 30, 1888.

During the months of July and August the Missouri River was unusually high, and the back water from it rendered contemplated work on the Gasconade River impracticable.

On August 3 a general project for the improvement of the river from Third Creek to the mouth was submitted for your consideration.

After a personal examination by yourself of the bar at Round Island, on the 5th of September, verbal instructions were received, in which the location of the line of improvement was indicated, and the proposed plan of structure of the letter of August 3, modified in certain details, was approved.

Preliminary work in the way of the repair of plant was begun on August 24 and continued until September 12, inclusive.

On September 13 a party was organized and work began on the same day at Round Island.

On October 22 the constructed dam was regarded as in good condition to leave for the winter, and work at that point ceased.

On the same day the plant was moved down the river to Bock's Bar, distant from Round Island 5 miles and from the mouth of the river 2 miles.

Active operations were begun at Bock's Bar Monday, October 24, and continued up to and including November 21.

On November 22 the flat-boat was loaded with all tools, tents, etc., and floated to Hermann. All tools, etc., were stored dry and in good condition. On November 23 the flat-boat was taken over to the left bank of the Missouri River and hauled out upon high ground. On the same day the party was discharged.

The work at Round Island consisted of a dam or training-wall 613 feet in length, with an average height of 3 feet. About 90 feet of the lower end was simply a foundation of sills with cross-logs bolted across the ends, covered with coarse gravel to the depth of 2 feet.

The object contemplated at Round Island was the concentration of the low-water flow in the left chute by closing a chute to the right, which heretofore has conducted away one-half of it at the lowest stage.

The work at Bock's Bar consisted of a dam 330 feet long with an average height of 3 feet. The object contemplated at this point was exactly the same in terms as at Round Island. The plan of structure of the letter of August 3 as approved was followed at both points. Cribs were built of small logs, 8 inches smallest diameter, log-cabin style, with very little notching at points of intersection, where they were bolted together with ¾-inch iron bolts. The cribs were built 20 by 6 feet, outside measurement, and to such heights as the varying levels of the river-bed indicated. These open-work cribs were set with their longest lines parallel with the line of direction of the dam, and were filled with riprap rock to the height of 3 feet.

At Round Island, as the dam would act in some measure as a training-wall, riprap rock was deposited upon the back or low-water channel side, to the height of the crib structure and with a natural slope to the bed of the river.

At Bock Bar the structure was the same, but the apron was placed upon the front or down-stream side of the dam.

The roots in each case were well protected by riprap, and at Bock's Bar the right bank root was protected by a log mat 10 feet wide, loaded with rock.

The total length of structure at Bock's Bar, including mat, is 340 feet.

All troublesome snags of which complaint was made were also removed, and the Gasconade River, as far as snags are concerned, is now in good navigable condition from Arlington to the mouth.

* * * * * * *

I have the honor to be, very respectfully, your obedient servant,

J. W. BEAMAN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

W 4.

IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS.

The project for the improvement of this stream has consisted in the removal of obstructions to navigation, such as snags and leaning trees, the dredging of channels through shoal places, and the construction of cross and wing dams to concentrate the water over shoal places.

No work was done on this stream for the fiscal year ending June 30, 1888. A personal inspection was made in March and it was found that the work of the previous season had so far removed the obstructions that it was considered best to hold the funds to be used for the coming season, as no certainty of another appropriation was evident. The reading of the gauge at Tuscumbia was kept up and the plant cared for at Hermann and used on the Gasconade River, where the need of improvement was more imminent.

With the funds available and the amount asked for fiscal year ending June 30, 1890, it is proposed to continue the removal of snags, etc., and to raise and repair the wing-dams already built, and if necessary put in some new ones.

The former appropriations are:

By act of—	
March 3, 1871	$25,000
June 10, 1872	25,000
March 3, 1873	25,000
June 23, 1874	25,000
June 18, 1878	20,000
March 3, 1879	20,000
June 14, 1880	30,000
March 3, 1881	20,000
August 5, 1886	10,000

Money statement.

July 1, 1887, amount available	$5,972.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,816.63
July 1, 1888, balance available	4,155.48
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	9,155.48
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

Shipments down the river:	
Railway ties, 1,000,000, at 33⅓ cents	$333,333.33
Oak logs in rafts, 880,000 feet, at $8 per thousand	7,040.00
Walnut logs in rafts, 100,000 feet, at $20 per thousand	2,000.00
Ash logs in rafts, 80,000 feet, at $10 per thousand	800.00
Elm logs in rafts, 80,000 feet, at $6 per thousand	480.00
Estimated value of steam-boat commerce	164,107.50
Total value of down-river commerce	507,760.83
Shipments up the river:	
Estimated value of steam-boat commerce	75,653.50
Total value of Osage River commerce	583,414.33

The above estimate, based upon the best data available, does not show any material change in the value of the river commerce. The estimate of the value of the commerce for the year ending June 30, 1887, based upon data as trustworthy as that of the present year, was $605,916.53. The railway-tie and raft commerce has been fully up to its usual amount and value. Of the 1,000,000 ties rafted, 47,000 were taken out of the river at Warsaw, 170 miles above the mouth, 300,000 at Bagnell, 70 miles above the mouth, and the remainder at the mouth.

There were also taken out of the river at Warsaw 400,000 feet of lumber in oak logs, and 200,000 feet of lumber in walnut logs.

The steam-boat commerce, which appears to be somewhat less in value this year than usual, was mostly confined to that portion of the river below Tuscumbia, upwards of 60 miles above the mouth of the river.

The following steam-boats were engaged in the Osage River trade during the past year: *General Meade, D. B. Hurlbut, Black Diamond,* and *Frederick.*

The combined registered tonnage of these boats is not far from 300 tons.

With the exception of the *General Meade* the above are used as tow-boats, and barges are utilized in the transportation of merchandise.

The above report, meager as it is in details, gives without any doubt a just estimate of the commercial interests of the *Osage River.*

W 5.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER AT RUSH ISLAND BEND AND IVY LANDING, ILLINOIS, WITH A VIEW TO CONFINING AND DEEPENING THE CHANNEL.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 8, 1888.

SIR: I have the honor to submit herewith a copy of a report to this office from Maj. A. M. Miller, Corps of Engineers, of the results of * * * the examination† * * * of the Mississippi River at Rush Island Bend and Ivy Landing, with a view of confining and deepening the channel. As this locality will, at the proper time, be treated as part of the general plan of improvement, it is deemed advisable to defer work upon this bend until it is reached by the improvement in progress, which may result in rendering any work here unnecessary.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., February 24, 1888.

SIR: In compliance with letter dated office Chief of Engineers, U. S. Army, Washington, D. C., October 28, 1886, to this office, then under Maj. O. H. Ernst, Corps of Engineers, I have the honor to report as follows on an examination of the "Mississippi River at Rush Island Bend and Ivy Landing, with a view to confining and deepening the channel, Illinois."

Major Ernst, in his letter to the Chief of Engineers, U. S. Army, dated November 1, 1886, states that no funds are necessary for the preliminary examination of this locality in view of the information in this office.

Rush Island Bend and Ivy Landing is a locality on the Mississippi River, left bank, about 40 miles below Saint Louis.

The improvement of this portion of the river is contemplated in the general project for the improvement of the Mississippi River between the mouths of the Ohio and Illinois rivers, and is better treated as belonging to this project as a whole than as a separate work.

The project for the improvement of this portion of the Mississippi River contemplates a continuous extension of works from Saint Louis downstream, and this work, which has been successful, as far as carried on, has reached a point about 22 miles below Saint Louis and 18 miles above Rush Tower Bend. The river at this point, Rush Tower Bend and Ivy Landing, is not now giving any special trouble to navigation. The bend is caving, but the channel follows the bend and remains good.

When the general work reaches this point will be the proper time to take measures for the permanence of the river. If an attempt was made

† Provided for in river and harbor act of August 5, 1886.

›resent to hold this bend it might be useless work, as when the per-
ıent improvement reaches this point the regimen of the river may be
ı that no work would be required.

; is, in my opinion, better, then, to leave this work until it becomes
essary as a part of the general project, especially as at present no
›nvenience results to navigation.

ı view of the above, in my opinion, the "Mississippi River at Rush
ver Bend and Ivy Landing, with a view to confining and deepening
channel, Illinois," is not at present worthy of improvement, as it is
›e treated as a part of the general plan for improvement of the river
.he proper time.

Very respectfully, your obedient servant,

A. M. MILLER,
Major Corps of Engineers.

'he CHIEF OF ENGINEERS, U. S. A.

W 6.

:ELIMINARY EXAMINATION OF KASKASKIA RIVER, ILLINOIS, FROM NEW ATHENS TO ITS MOUTH.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., December 27, 1886.

ENERAL: In compliance with instructions contained in letter from
ce of the Chief of Engineers, U. S. Army, Washington, D. C., Sep-
nber 27, 1886, I have the honor to make the following report upon a
›liminary examination of the Kaskaskia River, from New Athens to
mouth.

The present mouth of the Kaskaskia River is at a point on the Mis-
sippi River about 3 miles above the town of Kaskaskia, or about 14
les above Chester, at which point it formerly emptied into the Missis-
pi River. In April, 1881, the Mississippi River broke through, or
med a "cut-off," into the Kaskaskia at its present mouth. The level
the Mississippi River at the present mouth, being about 6 feet above
ıt at the former mouth of Kaskaskia River, caused a complete change
the depth of water in the latter river. At most stages of water the
ckwater of the Mississippi now reaches up the Kaskaskia River as
as Evansville, a distance of 24 miles from the mouth, and the low-
ter navigation of the river is dependent upon the stage of water in
Mississippi River, the current at low water being almost imper-
›tible. The Kaskaskia is a tortuous, sluggish stream with stable
nks and remarkably free from snags. At a low-water stage of the
ssissippi, 0.5 feet on the Saint Louis gauge, 3 feet can be carried to
Evansville Bridge, except over two places—one, the lower, being
led Nine-Mile Shoal, about 6 miles from the mouth, and the other, a
›al immediately in the vicinity of Evansville. On the Nine-Mile
›al there is 9 inches of water at this stage of the Mississippi River,
feet on the Saint Louis gauge, and a few inches more at the Evans-
e Shoal. Between Evansville and the bridge near Baldwin, a dis-
ce of about 14 miles, the principal obstruction is Anderson's Shoal,
ich is a ledge of rock crossing the river. Just above the bridge at
dwin there is what is called the "Fish Trap." This is an obstruc-
ı built in the stream for the purpose of setting fish-nets. This is

the only obstacle to New Athens. As far as could be ascertained r serious shoaling has occurred in the slack-water portion of the riv due to sediment from the Mississippi River, and it would appear th with a small expenditure a 3-foot depth of water at a 6-foot stage of t Mississippi at Saint Louis could be obtained from New Athens to t mouth. The bridges on the river below New Athens are two, a railro bridge near Baldwin and a county or highway bridge at Evansvil these bridges have draws in them of 80 feet in the clear, and would n interfere with the navigation of the river materially.

The town of Evansville, about 32 miles by river from Chester, is place of 600 inhabitants, and is dependent upon the river for its su plies. It is a center of supply for the neighboring country, and here operated a mill which has a yearly output of 50,000 barrels of flou grinding 200,000 bushels of wheat annually, which is hauled to mil mostly by the surrounding farmers. This flour is all shipped by rive to Chester, whence it is shipped south. I was informed that the valu of the general merchandise sold in Evansville yearly was about $60,000 and that about $8,000 worth of agricultural implements were sold las year.

At New Athens, a town of about 1,000 inhabitants, there is anothe flouring mill which has an output of about 50,000 barrels yearly. A this point the Saint Louis and Cairo Short Line Railroad crosses th river, and at present all freight is carried to and from this place by thi means. Boats had heretofore not been able to reach New Athens, a the Baldwin Bridge formerly had no draw, but the new bridge has draw, thus opening up the river to this point.

The country through which the river flows is thickly populated, an is a rich agricultural country, being the great wheat-producing portio of Illinois. At present the low-water navigation of the river is carrie on by steam-boat, the *Nick Saur*, Captain Neville, owner and maste She is 100 feet long, 18 feet beam, 4 feet depth of hold, can be load to a draught of 3½ feet; tonnage, 99.22. When the stage of water w not permit her to pass the Nine-Mile Shoal the freight is transferred t flats at this point to a smaller boat, the *Little Nick*.

The amount necessary to improve this river to give 3 feet at ordina low water is probably small, but no estimate of the amount can be ma without a survey of the shoal points. It is estimated that this surv could be made for $1,200, and it is respectfully recommended that th amount be allotted in order that a report as to whether the stream worthy of improvement can be made. If it is found that this amou is reasonable I am of opinion that the stream is worthy of improveme as it would open the river for a 3 foot navigation at low water, and of great benefit to all the country along the river between New Athe and its mouth.

The commercial statistics of the river are as follows:

Articles.	Value.	Articles.	Valu
50,000 barrels flour	$200,000	400 barrels lime	$
General merchandise	60,000	200 barrels salt	
34,000 bushels wheat	21,400	Cooperage material	5,
Agricultural implements	8,000		
5,000 sacks bran	6,030	Total	301,

The above is the present commerce of the river, and includes only t portion from Evansville to the mouth. If the river were improved

that 3 feet could be carried to New Athens this amount would be increased, possibly doubled.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. JAS. C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF KASKASKIA RIVER, ILLINOIS, FROM NEW ATHENS TO ITS MOUTH.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., February 24, 1888.

SIR: In compliance with instructions contained in letter dated office Chief of Engineers, U. S. Army, Washington, D. C., March 16, 1887, I have the honor to make the following report on the survey of the "Kaskaskia River, from New Athens to its mouth, Illinois."

A party was organized and sent to the mouth of the Kaskaskia River for its survey on November 2, 1887, under charge of Mr. C. D. Lamb, assistant engineer. This was the most favorable time for a survey, it being the season of extreme low water. The survey was completed to New Athens on December 3, 1887, and the chart has since been platted in this office.

The Kaskaskia River drains about 5,000 square miles of country, and from New Athens to its mouth is a distance of 43 miles. The principal towns in this stretch of the river are Evansville, about 500 inhabitants, 12 miles from the mouth; Baldwin, 400 inhabitants, 22 miles from the mouth; and New Athens, 1,000 inhabitants, 43 miles from the mouth. The country between New Athens and the mouth is rich farming land, producing principally wheat; cord-wood is also still abundant along the river and is shipped by boat to Saint Louis. At New Athens is a flour mill, with an annual output of 50,000 barrels flour, and at Evansville there is a mill of the same capacity.

At present the commerce of the river is confined principally to the portion below Evansville, and consists in the moving of the farm products, flour, and supplies for the country bordering the stream.

The river is crossed at New Athens by two bridges without draws, one being the bridge of the Cairo and Saint Louis Railroad, the other a highway bridge. At Baldwin the Mobile and Ohio Railroad crosses the river on a draw-bridge with 90 feet draw openings; a fourth bridge at Evansville is a highway bridge with draw openings of 80 feet.

At high water the river is navigable to New Athens. At low water the river is obstructed by shoals, snags, and bars, and depends for its navigation upon the stage of the Mississippi. Formerly the mouth of the river was at Chester, Ill., but in 1881 a "cut-off" in the Mississippi River occurred near the town of Kaskaskia, which moved the mouth of the river about 7 miles up-stream; this benefited the navigation of the Kaskaskia, for the present mouth is at a point on the Mississippi River about 6 feet in elevation above its former mouth, and thus the backwater from the Mississippi gives this much more depth at the same stage, prolonging the season of low-water navigation.

The first serious obstruction met with in ascending the river is what is called the "Nine-Mile Shoal," 6 miles above the mouth. It is a ledge of rock extending across the river; on this there is only about

9 inches available at a 6.5-foot stage (Saint Louis gauge) of the Mississippi River. An attempt was made in 1870 to improve this shoal by the "Okaw Navigation Company," but since the "cut-off" changed the regimen of the river the work has failed to give relief.

The next obstruction met with is a shoal at Evansville consisting of bowlders and gravel. It is estimated that these two obstructions can be removed so as to give a low-water depth of 3 feet at a Mississippi stage of 6.5 feet at a cost of $6,000.

The obstructions between Evansville and the Baldwin Bridge consist of a gravel-shoal at Plum Creek, 2 miles above; a gravel-bar 4½ miles above, and snags and drift-wood. It is estimated that the removal of the obstructions named will cost $4,500. Above Baldwin the work of improvement would consist in the removal of snags, drift, and leaning timber. At present the commerce of this portion of the river is not worthy an outlay of Government funds.

It does not appear at present that the needs of commerce require the improvement of the river to any point above the Baldwin Bridge, as it is not probable that the river traffic above this point could compete with the railroads. It would seem advisable and in the interests of economy to first open the river for low-water navigation to Evansville, to give an outlet for this trade, and if the demands of commerce hereafter may require the improvement could be continued up-stream.

I therefore submit an estimate of $6,000, for which sum navigation to Evansville will be greatly improved during the season of low water. Mr. Lamb's report is appended. I have increased his estimates, as in works of this character, when the appropriation is small, the contingencies are proportionally great.

The report of Mr. Lamb contains the commercial statistics, as far as could be ascertained.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. D. LAMB, ASSISTANT ENGINEER.

SAINT LOUIS, MO., *December 27*, 1887.

SIR: I have the honor to submit the following report on the survey of the Kaskaskia River during the half year ending December 31, 1887.

In accordance with your letter of instruction, dated October 28, 1887, a party, consisting of one assistant engineer, one leveler, one cook, and four skiffmen, was organized November 1, and the survey began the next day. It consisted in locating the shore-lines, taking soundings, and running a line of levels from the mouth to New Athens, a distance of 43 miles.

The shore-lines were located by triangulation extended up-stream from a base-line laid off on the bar opposite the mouth of the river. This base-line, 2,000 feet long, was measured three times with a steel tape, and the difference between the greatest and least results was about three-tenths of a foot. The topography was put in and the sides of the triangles measured as a check by the stadia-rod.

Triangulation points were permanently located by hubs, and bench-marks put in at the mouth of the river, Nine Mile Shoals, Evansville, Baldwin Bridge, Perkin's Lake, and New Athens.

Soundings were taken at each triangulation station, or at intervals of about 500 feet, except on the shoals, where soundings were taken every 100 feet.

During the early part of November the river was very low, but a rise began November 25, when the survey had been extended to Perkin's Lake, about 8½ miles above Baldwin, which continued until after the work had been completed to New Athens, December 3.

The elevation of the water-surface at various places, both before and after the rise, is shown in the following table:

Locality.	Elevation.		Remarks.
	Before rise.	After rise.	
Bench-mark at mouth of Kaskaskia	100.00	100.00	
Mississippi River at mouth of Kaskaskia	71.45	69.75	Reduced to 5.1-foot stage.
Kaskaskia 500 feet above mouth	71.61	70.54	Above Mud Bar.
Kaskaskia at lower edge Nine Mile Shoals	71.52	74.74	
Kaskaskia at upper edge Nine Mile Shoals	71.72	75.20	
Kaskaskia at lower edge Evansville Shoals	71.75	.....	
Kaskaskia at upper edge Evansville Shoals	71.84	79.48	
Kaskaskia at lower edge Plum Creek Shoals	71.88	.....	
Kaskaskia at upper edge Plum Creek Shoals	71.98	.....	
Kaskaskia at lower edge Anderson's Shoals	72.06	.....	
Kaskaskia at upper edge Anderson's Shoals	72.29	.....	
Kaskaskia at Baldwin Bridge	72.59	84.10	
Kaskaskia at New Athens	81.34	94.35	

The Kaskaskia River rises in Champaign County, Ill., runs in a southwesterly direction through Douglas, Coles, Moultrie, Shelby, Fayette, Bond, Clinton, Washington, Saint Clair, and Randolph counties, and, until April, 1881, emptied into the Mississippi about a mile above Chester, but at that time the Mississippi cut away a narrow strip of land which separated it from the Kaskaskia, and the mouth of the latter is now about 9 miles from Chester, or 66 miles below Saint Louis. The river is about 250 miles long and drains about 5,000 square miles of territory.

The only towns situated near the navigable portion of the river are Evansville, 12 miles from the mouth, with a population of about 500, where there is a wagon-bridge with a draw-span 80 feet wide; Baldwin, 22½ miles from the mouth, with a population of about 400, on the Mobile and Ohio Railroad, which crosses the river on a bridge having a draw-span 90 feet wide in the clear; and New Athens, 43 miles from the mouth, which has a population of about 1,000. The last-named place is considered as the head of navigation on the Kaskaskia, for it is there crossed by two bridges without draws—the lower one for wagons, the other used by the Cairo Short-line Branch of the Saint Louis, Alton and Terre Haute Railroad.

The navigation of the Kaskaskia River was begun in 1837 by a small boat called the *Wild Duck*, running from Chester to New Athens. The business done by boats increased as the country near the river was settled, but was largely diverted to the railroads, which now cross the river at various points.

A large section of the country south of Baldwin and near the river has always been able to ship freight by boat cheaper than by rail. This section includes the town of Evansville, which contains a flour-mill with a capacity of 50,000 barrels a year, a large cooper's shop, and four stores. Boats have, therefore, continued running in the Kaskaskia at all navigable stages, but since 1881 changes have taken place in the regimen of the river which have made it impassable at low stages. The channels around the shoals have been filled up during the long-continued high water of 1881, 1882, and 1883, and many of the bends between Anderson's Shoals and New Athens are closed by snags at all except high stages.

The only boat now running steadily on the river is the *Nick Sauer*, owned in Chester. This boat is 100 feet long, 18 feet wide, and 4 feet deep, with a tonnage of 99.27. It makes daily trips between Chester and Evansville during harvest time, and three trips a week during the remainder of the season of navigation, together with trips to points above Evansville as often as the business offered will justify.

A smaller boat, called the *Little Nick*, is also used during low water for transferring freight on flats between Evansville and the mouth of the Kaskaskia.

The amount of freight carried by these boats during the past season was about as follows:

	Tons.
Flour from Evansville to Chester, 25,000 barrels	2,500
Bran and shipstuffs, Evansville to Chester	400
Wheat, various points, to—	
Chester	500
Evansville	800
Coopers' materials from Chester to Evansville	400
General merchandise from Chester to Evansville	240
Farm produce from Evansville to Chester	260
Total	5,100

About 2,500 cords of wood were also loaded upon barges at various points on the river below Baldwin and towed to Saint Louis by the tow-boats *Dolphin* and *Mary Michael*.

While navigation is suspended on the Kaskaskia all Saint Louis freight is hauled in wagons to and from Red Bud, 11 miles distant, the nearest town on the Mobile and Ohio Railroad, and freight for southern points is hauled to Chester, 18 miles distant.

The average time during which navigation is suspended on account of low water in the Kaskaskia is now much less than before the cut-off mentioned as occurring in 1881. The surface of the Mississippi at the cut-off is about 7 feet higher than at the old mouth, and backwater from the Mississippi at medium and high stages now increases the depth of water in the Lower Kaskaskia by about that amount, so that though previous to 1881 a 15-foot stage in the Mississippi at Saint Louis was required to give 3 feet of backwater on the shoals below Evansville during low stages of the Kaskaskia, that depth can now be found with the Saint Louis gauge reading 8 feet.

During the high-water years of 1881, 1882, and 1883 navigation between Chester and Evansville was only interrupted by ice, but during the last four years navigation has been suspended on account of low water on the shoals in the Kaskaskia for an average time of eight weeks. The freight hauled to and from Chester and Red Bud during these eight weeks, with the increase in the cost of its transportation, is about as follows:

50 tons merchandise, at an increased rate of $2 per ton	$100
25 tons produce, at an increased rate of $2 per ton	50
100 tons coopers' material, at an increased rate of $1 per ton	100
150 tons wheat, at an increased rate of $1 per ton	150
600 tons flour, at an increased rate of $1 per ton	600
Total	1,000

The Kaskaskia above Evansville flows through a fine farming country, but its surplus products are all shipped by rail except the wheat, which is nearly all purchased by the flouring-mills.

About 1,500 tons of freight are annually shipped to and from Baldwin, on the Mobile and Ohio Railroad, by which it is 45 miles from Saint Louis. The town is 2¼ miles from the river, and the cost of hauling that distance would be added to the rates by boat.

The freight to and from New Athens, amounting to about 6,500 tons a year, is now shipped on the Saint Louis, Alton and Terre Haute Railroad, by which it is but 29 miles from Saint Louis.

The only places on the Kaskaskia River below Evansville where there is less than 4 feet of water, with the Mississippi 6.5 feet above low water at Saint Louis, are the mouth of the river, mouth of Nine Mile Creek, and just below Evansville. The river is also obstructed by a few large snags, the most troublesome of which are at the mouth of Camp Creek, 1½ miles below Evansville.

The shoal at the mouth of the river is caused by a mud-bar on which there was but 18 inches of water during the first part of November, but the mud was so soft that a channel could have been washed through it in a few hours by the wheel of a tow-boat.

The shoal at Nine Mile Creek is about 6 miles from the mouth of the river. The obstruction consists of a ledge of rock extending across the river from the high ground on the east side.

The location of the ledge and the depths of water in its vicinity are shown on the accompanying tracing.

This shoal has always been considered a serious obstruction to navigation, and in 1870 the dam shown on the tracing was built by the Okaw Navigation Company, with money raised by subscriptions and taxes on the land near the river. Its object was to force the river to the west of the ledge down through the bar now found on that side. This attempt was a partial success. A narrow channel was cut around the ledge during low water, but it was closed by sand deposited during the high water of 1881, and the bar is now so high that its removal would cost more than to blast a permanent channel through the ledge.

To obtain a channel having a minimum depth of 3 feet at this locality with the Mississippi River 6.5 feet above low water at Saint Louis, the bed-rock must be loosened by blasting and removed to a depth of about 19 inches. The red contour lines on the tracing show that the least excavation would be required in making a passage about 100 feet west of the present channel.

To make a passage-way through the ledge 100 feet wide and of exactly the desired depth, would necessitate the removal of about 900 cubic yards of bed-rock. This amount would probably be increased by the removal of rock below the desired depth, but as the rock on the surface of the ledge is soft and the strata thin, the amount re-

moved would not probably exceed 1,350 cubic yards, which at $2 per yard would cost $2,700.

The shoal at Evansville is caused by a bar of gravel and cobble-stones mixed with small bowlders. The accompanying tracing shows the location of the shoal and depths of water at the time of the survey.

The removal of about 750 cubic yards of loose rock and gravel would make a channel at this place 100 feet wide and 3 feet deep when the Mississippi River was 6.5 feet above low water at Saint Louis. This excavation at $1 per yard would cost $750. The snags now obstructing navigation below Evansville could be removed in about five days by a party equipped for that purpose at an expense of about $40 per day, or $200.

The cost of improving the river from the mouth to Evansville would, therefore, be made up as follows:

Improving Nine Mile Shoals	$2,700
Improving Evansville Shoals	750
Removing snags	200
Engineering and contingencies, 25 per cent	900
Total	4,550

The above amount is the estimated cost of securing a channel of the desired depth, 100 feet wide, but the pilots of the boats that now run on the river think that a channel 75 feet wide would accommodate all the commerce of the stream. For a channel of that width the cost given above can be reduced to about $3,400.

This improvement would result in an average annual saving of about $1,000 to the people of Evansville and its vicinity, or nearly 30 per cent. of its cost.

The obstructions to navigation between Evansville and Baldwin consist of the shoals at the mouth of Plum Creek, 2 miles above Evansville; Anderson's Shoals, 1½ miles further up-stream; a gravel bar 4½ miles above Evansville; and the snags and heavy drift that close the channel in many of the bends. Plum Creek and Anderson's Shoals are shown in the accompanying tracings. The bars in each are composed of cobble-stones and small bowlders mixed with gravel.

The cost of securing a channel 100 feet wide, of the desired depth, from Evansville to Baldwin Bridge would be as follows:

Plum Creek Shoals, removing 700 cubic yards of loose rock and gravel, at $1 per yard	$700
Anderson's shoals, removing 1,200 cubic yards of loose rock and gravel, at $1 per yard	1,200
Gravel shoal above Anderson's, removing 900 cubic yards of sand and gravel, at 50 cents per yard	450
Snags and drift, services of party equipped for that purpose, 20 days, at $40 per day	800
Engineering and contingencies	800
Total	3,950

For a channel 75 feet wide this amount could be reduced to about $3,000. The improvement of this part of the river would allow a regular steam-boat service to be established between Baldwin and Evansville, and would also largely increase the output of wood and timber.

Below Baldwin Bridge the Kaskaskia is comparatively straight, with muddy banks, and at low water is made up of long pools with no fall or current, separated by shoals of rock or gravel, but above Baldwin the river becomes very crooked, the distance from that point to New Athens by water being more than double that by road. The banks and bars are in many cases composed of sand, and as its bed has a nearly uniform fall of .5 of a foot to the mile, there is a current of considerable strength.

The most serious obstruction to the low-water navigation of the river between Baldwin and New Athens is a dam built about 20 feet below their bridge by the Mobile and Ohio Railroad Company for the purpose of keeping the level of the water above the wooden foundation of the piers. It had not been completed at the time of the survey, but the foreman in charge of its construction stated that it was to be carried to a height equal to that of the river, with the Saint Louis gauge-reading 7.8 feet.

The river is also obstructed by what is called the "Fish Trap," just above the bridge, and by sand-bars and snags at various places. The cost of removing these obstructions can not be estimated very closely, as only that portion from Baldwin to Perkin's Lake was surveyed during low water.

The sand-bars are very numerous, and experience on other rivers of a similar character has shown that such localities can only be permanently improved by locks and dams at an expense which the commerce of the Kaskaskia would never justify. The

removal of the snags and drift, however, would clear up a channel in which there would be a minimum depth of 3 feet at all except very low stages of the river, The "Fish Trap" mentioned consists of heavy stakes driven across the river during low water by fishermen for the purpose of holding nets.

To remove this obstruction, together with the drift and snags, from a channel 75 feet wide between Baldwin Bridge to New Athens, would require the services of a party equipped for that purpose for about two months, at a cost of $2,400.

There is at present no commerce on this part of the river, but its improvement would furnish an outlet for large quantities of wood and timber, and after the improvement of the river below would render it possible for small steamboats to carry a large amount of freight between various points on the river and New Athens, Evansville, and Chester.

Very respectfully, your obedient sevant.

C. D. LAMB,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

APPENDIX X.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

REPORT OF CAPTAIN E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORK.

UNITED STATES ENGINEER OFFICE,
Quincy, Ill., July 7, 1888.

SIR: I have the honor to render the following report of operations for the fiscal year ending June 30, 1888, in the improvement of the Mississippi River between the Des Moines Rapids and the mouth of the Illinois River.

UNITED STATES TOW-BOAT COAL BLUFF AND PLANT.

This fleet was engaged July 1, 1887, under my personal charge, in constructing works of contraction in the vicinity of Cap Au Gris. Brush was cut by United States laborers, rock obtained at Grafton under contract, and the work done by hired laborers paid and subsisted by the United States. During the last week of June a dam about 1,600 feet long was begun to connect Island 500 with the Illinois shore. This work was executed under difficulty, for the water fell continually, and access to the line of the dam was tedious, and finally became impossible except by too long a transfer of material to render it economical; so work was suspended near the end of July, when the dam was about three-fourths completed. The water remained low during the rest of the season and it was not practicable to complete it. It should have been finished early this spring, but as there were no funds on hand this could not be done, and doubtless much of the unfinished work has been injured or destroyed. The following amounts of material were placed in this dam after July 1: 4,627 cubic yards of rock, 3,762 cubic yards of brush; total, 8,389 cubic yards of material.

Upon the dam connecting Islands 500 and 501 there was placed enough rock to fill a hole caused by settlement, 167 cubic yards of rock.

To finish the shore protection on Island 500, begun and nearly completed before July 1, there were used 365 cubic yards of rock.

The shore protection of the concave bend at Cap Au Gris, on the Missouri shore, of which 1,986 linear feet had been laid, was extended to a total distance of 3,392 feet, and consumed 2,375 cubic yards of rock; 1,339 cubic yards of brush; total, 3,714 cubic yards of material in this fiscal year.

The completed work has used 6,228 cubic yards of rock; 3,927 cubic yards of brush; total, 10,155 cubic yards of material.

After August 1 Mr. J. E. Blakemore was placed in the position of overseer of the fleet and remained as such until near the end of the season.

As the work near Cap Au Gris approached completion a beginning was made at Martin's Landing, some 5 miles lower down, on approved projected works for that vicinity. A dam 1,225 feet long, resting on a brush sill 60 feet wide, but composed entirely of rock above the sill, was built to connect Barrack and Cuivre islands. This dam rises to a height of 6 feet above low water. It was begun in August and finished October 11, and consumed 9,951 cubic yards of rock; 3,322 cubic yards of brush; total, 13,273 cubic yards of material.

The head of Barrack Island was protected with the usual mat, 35 to 50 feet wide, well riprapped, for a distance of 1,187 feet, and there were used 1,646 cubic yards of rock; 338 cubic yards of brush; total, 1,984 cubic yards of material.

While this was being done the head of Island 507 was protected in a similar manner and for about the same distance, using 2,739 cubic yards of rock; 1,393 cubic yards of brush; total, 4,132 cubic yards of material. Both of these islands were finished by October 22. To prevent a large bar above Martin's Landing from moving further down the river, a protection 670 feet long and 20 feet wide, but only 18 inches high, was built across the highest part. It is hoped this may facilitate deposits below the protection and eventually a growth of willows. There were used in this work 1,469 cubic yards of rock; 799 cubic yards of brush; total, 2,268 cubic yards of material.

The final work of the season was the repairing and filling up to standard height Dardenne Island Dam, taking 2,211 cubic yards of rock, and the repairing of the shore protection of Botter's Island Tow-head, and the small and long dams running therefrom. This consumed 1,583 cubic yards of rock. Work closed hurriedly November 12, with the exhaustion of the appropriation, and the fleet was laid up in Hamburg Bay, except the *Coal Bluff*, which was brought to Quincy Bay. After July 1 the *Coal Bluff* and plant placed during the season 27,134 cubic yards of rock; 10,953 cubic yards of brush; total, 38,087 cubic yards of material.

CONTRACT WORK.

Mr. H. S. Brown finished his contract for repairs of the Gilbert Island works during July, 1887, putting on third wing-dam 298 cubic yards of rock and 213 cubic yards of brush; on main dam, 903 cubic yards of rock and 486 cubic yards of brush; on shore protection (1,052 feet), 1,370 cubic yards of rock and 1,454 cubic yards of brush; total, 4,724 cubic yards of material.

Mr. Brown carried out his contract with fidelity and exactness, and placed altogether 15,163 cubic yards of material during the working season upon the various works at Gilbert's Island. The success of the system during the season was marked, and no delay occurred anywhere within the area dominated thereby. It was shown conclusively that the main dam threw 18 inches of water around the channel-chute, and that the scouring action thereof was powerful in maintaining the channel. Mr. A. J. Stibolt was the inspector for this contract. Messrs. Patterson Brothers finished the main dam at Turner's Island on August 2, using 1,852 cubic yards of rock; 2,097 cubic yards of brush; total, 3,949 cubic yards of material. This dam is 1,880 feet long, rests on a brush sill 60

feet wide, and was built to a height of 5.5 feet above low water. The shore protections are 275 feet long by 35 feet wide, and 300 feet long by 50 feet wide.

The head of Stag Island was then protected by a mat, which was carried around to the short but high dam connecting the island with the Missouri shore, also protected for a short distance. Dam 610 feet long; crest 10 feet above low water; mat 60 feet wide; protections 200 feet by 20 feet and 450 feet by 50 feet; 3,201 cubic yards of rock; 2,559 cubic yards of brush; total, 5,760 cubic yards of material.

This work was finished September 5, and the final work was a wing-dam from the foot of Stag Island and extended out 900 feet. The height at shore was 6 feet above low water, dropping down to 3 feet at 850 feet out. This was finished on October 11. Material used, 3,926 cubic yards of rock, 3,068 cubic yards of brush; total, 6,994 cubic yards.

The Messrs. Patterson Brothers have executed their contract with their usual precision and energy. Mr. J. C. McElherne acted as inspector during this contract, and was then placed in charge of the Coal Bluff.

Under proper authority bids were invited for the construction of a wing-dam 1,800 feet long from the Missouri shore to the crest of Whitney's Bar, some 5 miles above Hannibal. These bids were opened August 25 with this result:

Names and residences of bidders.	2,700 cubic yards brush.	5,300 cubic yards rock.	Aggregate.
H. S. Brown, Quincy, Ill	$0.80	$1.55	$10,375
Sidney J. Truax, Quincy, Ill	.80	1.60	10,640
Patterson Bros., Keokuk, Iowa	.82	1.58	10,588
Jacob Richtman, Fountain City, Wis	.72	1.53	10.053

The bid of Mr. Richtman was accepted and contract was entered into with him. Work began September 15 and was pushed vigorously to completion on October 29. Material placed, 5,220 cubic yards of rock, 2,832 cubic yards of brush; total, 8,052 cubic yards.

Whitney's Bar was one of the worst spots on this part of the river last season, and the closure of the false channel by the dam just put in will, I hope, help to keep a proper channel depth in the main channel. Mr. A. J. Stibolt acted as inspector under this contract. In all 67,567 cubic yards of material were placed in works of construction by all the fleets specified above during the season after July 1.

HYDRAULIC DREDGE.

The steam tow-boat *Success*, purchased as reported in my last annual report, and fitted up for use as an hydraulic dredge as described, is now ready for use. With her three boilers, capable of furnishing at a high pressure all the steam needed to drive the 12-inch centrifugal pump with which she is furnished, and also to supply the force-pump, steam hoister, rigging for operating booms and guys, and being at the same time the motor for herself and fleet of boats bearing 550 linear feet of discharge-pipe, the whole machine should do good and efficient work after experience shows how to use it to best advantage. The contractors for the discharge-pipe did not deliver the pipe until it was too late in the season to attempt any experiments. The only experience had thus far has been with the pump and a short piece of pipe. It was demonstrated,

however, that a dump-scow, 50 yards, could be loaded with sand in two and a half minutes, and as the original intention only aimed at one-tenth of such a delivery there seems nothing unreasonable in hoping that such an amount, 2,000 cubic yards, can be dredged in twenty-four hours and delivered 500 feet away from the site of dredging. There being no funds on hand no experiments were made in this spring. The fleet of decked flat-boats to carry the discharge-pipe, contracted for last spring, were delivered in August, and will serve the purpose admirably for which they were intended.

The extremely low stage of the water made a call for dredging temporary channels come from the navigation interests in July. The *Success* and the big dipper dredge worked on the crossing known as Lone Tree, a few miles above Quincy. For the greater part of three weeks this attempt to dredge a cut through the sand continued, and was finally abandoned as a failure. Compelled to work down-stream, the dredge was not able to take away the sand as quickly as the current would bring it down, and could never maintain what channel it succeeded in digging. It is hoped that the other method, hydraulic, will allow operations to be conducted in the reverse direction. The dredge, placed at the crest of the bar, will remove the sand as it comes to it, and the sand flowing down-stream and to the hole or crater thus dredged will necessarily bring with it the current, and whenever this flow of sand towards the dredge stops there will be a channel through the bar at that place. The dredge, lying in deep water below the bar, can not be grounded, nor need it move up-stream as long as the sand flows down to it. When it does move up-stream it will be when so much sand has been excavated that no danger of grounding exists. If an extra current is excited across the bar at the site of dredging, by the act of dredging, then the deep water below the bar furnishes a place of deposit for the extra scour, and the channel is the more rapidly established. The season of 1887 was remarkable as the most prolonged season of low water since the United States began the work of improvement in this section. The water fell slowly, however, and the channel was well established and of full depth. The usual class of passenger boats continued at work during the season.

The least depth in the channel between Keokuk and the mouth of the Illinois River was 3 feet 9 inches, but in many places the channel was shifting, insecure, crooked, or undefined. As a general rule nearly the same depth was found throughout the district, except that perhaps there were a few inches less water above Quincy than below it. Extreme low-water mark was reached by the Quincy Gauge, and for one day a tenth or so less than the low water of 1864. No greater channel depth was noted through the improved portions of the river than through those not touched. Again, on the other hand no markedly bad places were developed until near the end of the season, the universal pilot testimony being that "one part of the river is about as good as another." It is noteworthy that the Diamond Jo line of boats managed to run all the season without serious delay, and certainly did not find any particular place worse than another. This line of boats made no special complaint during the season, and did not ask for assistance of any kind at any time. If the channel could be confined to reasonable limits through the markedly sandy portions of the river, and at a falling stage the cutting process be assisted at the right time and place, all the interests of navigation would be secured. But it is more evident to me each year that new and rapid methods of dredging are of more value to this section of the river than anything else can be, lay-

ing aside all questions as to the ultimate success of any system of permanent improvement. I repeat that it is discouraging if not utterly hopeless to attempt to carry on a system of permanent improvement on the contraction system alone, under the present experience as to amounts appropriated for this portion of the river and the times when given.

The spring of 1888 has been noted for the highest flood recorded here since 1851. The gauge read 19.1 feet above the low water of 1864. All the levees of this region were broken in many places. Great damage was caused by the overflow of large areas of land. The levees were neither high enough nor strong enough to meet the exigency.

ESTIMATE FOR 1889–'90.

To continue the work as planned out for permanent improvement, I would select such of the permanent works as are most needed to provide resting places for the movable sands above and below them, and at the same time most desirable to limit the range of movement of the low-water channel. These, and the largest and most important island chute-dams, I would construct at once, and would proceed at the same time to gain control of the worst sand-bars by beginning during high water to pump them away from the main bed of the river to the island chutes or behind wing-dams. As the water fell I would facilitate the cutting of the low-water channel in its proper location through each bar, piling up the sand at some point where it would not get into the river-bed again. Every such dredging would then be in the nature of a permanent improvement. To do this well would require effective machines, and I would aim to secure them partly by experiment with our own machines, but principally by contract, inviting the application of new methods and machines on certain portions of the river. The two must go together. There must be receptacles for the dredged material to keep it from going back into the river, and these receptacles must be such as to contract the low-water bed, and there must be machines capable of moving, cheaply, large amounts of sand out of the river-bed, and of depositing this sand at a higher level not far away. My estimate would therefore be subdivided into—

Permanent works	$500,000
Dredging and dredging-machines	100,000
Total	600,000

Money statement.

July 1, 1887, amount available	$19,349.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,022.89
July 1, 1888, balance available	327.05
Amount appropriated by act of August 11, 1888	200,000.00
Amount available for fiscal year ending June 30, 1889	200,327.05
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	264,000.00

Very respectfully, your obedient servant,

E. H. RUFFNER,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 5, 1887.

SIR: The inclosed communication to this office from Capt. E. H. Ruffner, Corps of Engineers, dated August 19, 1886, submitting project for the improvement of the Mississippi River between the Des Moines Rapids and the mouth of the Illinois River, with the indorsements of this office and of the Secretary of War thereon, is transmitted for the information of the Board of Engineers constituted by Special Orders No. 77, Headquarters Corps of Engineers, dated October 4, 1887, of which you are the presiding officer.

It is desired that the Board give the subject careful scrutiny and consideration, and with this view it is authorized to call upon Captain Ruffner for any information he may possess or may be obtainable through his office bearing upon the subject and tending to its elucidation, or, if deemed advisable, the Board may request his attendance in person.

Finally, it is desired that the Board submit a specific project for the improvement of the reach of river in question.

The accompanying papers bearing upon the subject are transmitted for the information of the Board.

By command of Brigadier-General Duane.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

REPORT OF BOARD OF ENGINEERS.

OCTOBER 24, 1887.

GENERAL: The Board of Engineer Officers appointed by Special Orders No. 77, dated Headquarters Corps of Engineers, United States Army, Washington, D. C., October 4, 1887, "to consider and report upon the improvements of the Mississippi River from Des Moines Rapids to the mouth of the Illinois River," would respectfully submit the following report:

The Board met at Quincy, Ill., on the 19th of October, 1887, pursuant to the call of the senior member, all the members, the recorder, and Capt. E. H. Ruffner, Corps of Engineers, being present. On the afternoon of the same day they took the United States steam-boat *Success* and proceeded up the river as far as Canton, and thence down the river to the mouth of the Illinois, traveling only by daylight, and carefully examining the works of improvement completed or in progress.

The instructions of the Board direct a consideration of certain matters presented by Capt. E. H. Ruffner, in a project submitted to the Chief of Engineers, under date of August 19, 1886, "for the continuation of improvement of the Mississippi River between the Des Moines Rapids and the mouth of the Illinois River." The Board is also directed to "submit a specific project for the improvement of the reach of river in *question.*"

Three points are considered in the letter of Captain Ruffner. The first is a proposition that he be authorized to build a suction dredge-boat for use in his district. On this no action is necessary, as a suction dredge has already been built, with the sanction of the Chief of Engineers, by placing a 12-inch centrifugal pump, with suitable driving and priming engines, on the United States steam-boat *Success*.

The second point is a proposition from Captain Ruffner that he be authorized to operate the dredge during low water on such bars as may prove troublesome, for the purpose of giving temporary relief to navigation. Work of this nature has always been a part of the system of improvement heretofore carried out on the Upper Mississippi, and temporary channels have been cut at many points with varying success. While the members of the Board believe that mere dredging will hardly ever be permanently successful in a river-bed whose principal characteristic is moving sand, they nevertheless recommend the approval of Captain Ruffner's proposition, because, under existing arrangements, the work of dredging will cost comparatively little, and in many cases it may give temporarily most beneficial results. In any event the moral effect of the effort to assist navigation will be favorable, even if the effort itself should prove a failure. On account of a delay in obtaining the necessary apparatus for transporting the spoil the suction dredge has not yet been tested in actual work on a bar, but Captain Ruffner exhibited the working of the pump with a short piece of discharge-pipe and the result was exceedingly satisfactory.

The third point is a recommendation that the main work in this district be limited to the maintenance of existing dams and dikes and to dredging, and that no new work of permanent improvement be undertaken except in very limited quantity at localities where bad bars are developed or excessive caving occur or a regulation of the channel is necessary. In the same connection Captain Ruffner recommends that "any further definite plan of entire and ultimate contraction of the river to a fixed width, with protection of all caving banks and islands, should be suspended for the present or entirely abandoned, etc." To this, as an engineering proposition, the Board are decidedly opposed, being a unit in favor of the permanent improvement of the navigation of the Upper Mississippi to the full extent of the available funds. If Congress only appropriates enough money to keep up the existing dams and dikes, it is evident that new work can only be undertaken by neglecting old work, but even under such circumstances the Board think that it will often be wiser to start new works rather than keep up old ones, as the entire destruction of the latter is practically impossible, and they will usually exert a beneficial influence even if cut down to low water or below it. It should be noted, however, that the exceptions named by Captain Ruffner cover all the cases that are likely to be taken in hand for many years to come, unless Congress is more liberal with future appropriations than it has been with past ones; if, however, there should be money available for new work, under a definite plan of permanent improvement, the Board is unanimous in the opinion that it should be undertaken, and the class of new work cited by Captain Ruffner should certainly be the first to receive attention. Such work is similar to that heretofore carried out, and is in accord with the general system of improvement inaugurated on this stretch of river by Major Farquhar in 1879, with the sanction of the Board of Engineers, on low-water navigation of the Mississippi River, and continued by his successors. The great majority of the works thus far built in this section of the river have had a decidedly beneficial influence, and many bad

places have been radically improved. It often happens that the good effect of works of closure and contraction are not fully developed till after the lapse of considerable time, and many of the works that we examined are too recent to fully show the desired results; but out of the number that came under our notice there were only two or three concerning which we can express any doubt, and even in these cases we do not feel that we are sufficiently acquainted with local conditions to criticise the judgment of the officers who have been in local charge. As a general proposition, we are prepared to maintain that the expenditure of Government funds in this district has been wisely made, and that any errors of judgment which may have been developed by time are such as are natural in an untried field. Among the former bad places that have been greatly improved we would mention Warsaw, Gregory's Landing, Howard's, Quincy, Hannibal, Gilbert's Island, Louisiana, Slim Island, Turner's and Bolter's Island, the majority of which had for years an unenviable notoriety in the river trade. At two of the points mentioned some difficulty has been experienced since work of improvement was carried out, but such difficulty was temporary, and under the circumstances can not be considered as an evidence of a failure of the system of improvement heretofore followed.

In view of these facts the Board, while fully concurring in the recommendation that dredges be used for furnishing temporary relief and for securing more promptly the desired results from works of permanent improvement, can not concur in the suggestion that the method of improvement by contraction be entirely abandoned, regardless of the amount of funds available. On the contrary, they are of the opinion, judging from the results of the work already done, that the method of contraction and regulating by dams and dikes promises the best solution of the problem of the permanent improvement of this district of the Mississippi River.

The Board are instructed to submit a "specific project" for the improvement of the Mississippi River between Keokuk and the mouth of the Illinois River. In 1878–'79 a detailed survey of the river was made under Major Farquhar's direction, and on the basis of this survey a system of improvement was adopted, and a theoretical channel covering the entire stretch was laid down on the maps; approximate estimates of cost of a permanent improvement were also made. The system adopted was that of concentration; and this system has since received the approval of the War Department, of the Board of Engineers on the Improvement of the Low-water Navigation of the Mississippi River, and of the Mississippi River Commission. It being evident that the detailed consecutive plan would be liable to many alterations, due to changes of the river and to experience gained as the work progressed, the officers in charge have been led from year to year to substitute for the general plan indicated above projects for work on detached portions of the river, the points selected being those which were, for the time being or permanently, the greatest obstructions to navigation. All such projects have been based on the same general approved system of improvement, and each as presented has received the sanction of the proper authorities. This general system has consisted in the use of brush, piles, gravel, and rock in-shore protections, dikes and dams for the purpose of protecting caving banks, collecting and retaining sand and other material, forming new low-water banks, and gradually reducing the river to a uniform channel of such low-water width as to give promise of maintaining a sufficient depth for the purposes of navigation.

The general principles which guided Major Farquhar in laying out the proposed channel, as shown on the maps of his survey, are those usually accepted by engineers for works of river improvement of this character, and as such have been followed by his successors. But the lines laid down have never been officially adopted, and therefore the officers in charge have never considered themselves as bound to conform to them in detail, and they have built on these lines or not as local circumstances seemed to require.

It would therefore appear that while the general system of work, and the detailed work on detached portions, have been formally approved, no complete and consecutive plan for the improvement of the whole of this stretch of river has ever been officially adopted.

A "specific project" for the improvement of the reach of river in question must include a consecutive plan, defining by exact lines the limits of the channel that ought, if possible, to be obtained and maintained, and it is the opinion of the Board that such a plan is a necessity as a guide for future work. The gentle slope of the river, abundant supply of water, movable bottom, and excessive width, all combine to give the engineer great latitude in choosing a channel, and unusual prospects of success in maintaining it when once created. But it is evident that to define such a channel over a length of 122 miles of river requires detailed local knowledge of regimen and character of bed and banks and location of channels, that can not be acquired by a Board of Engineers Officers whose time is more than occupied in the care of their extended districts. It is therefore the judgment of the Board that as soon as practical a consecutive plan of the desired low-water channel of the river should be prepared upon maps of large scale by the engineer officer in local charge. The preparation of a new plan, rather than the formal adoption of that prepared in 1879, is recommended, to the end that the experience of the past seven or eight years may be utilized. Whether it is the duty of this Board to pass upon the plan when it may be presented it is not in their province to determine.

Any consecutive plan which may be prepared in accordance with the above recommendation will largely be based upon the present condition of the bed and channel of the river, and yet it may confidently be expected that great changes will take place before the plan can be carried out, which changes may call for modifications of the plan itself. Notwithstanding this expectation, it is thought proper and for the good of the work that a general consecutive plan, showing the outlines of the proposed channel, should be formally approved by the proper authority, and that it should be adhered to, excepting in cases where specific authority is granted for a change of plan.

The general system of work heretofore carried out for the permanent improvement of this section of the Mississippi River—that is, concentration and regulating by means of dams, dikes, and shore protection—should be continued, whenever funds are available for such work; and, as an auxiliary to such work of permanent improvement, the dredges now available should be used for giving temporary relief and for assisting in the formation of permanent low-water channels.

If funds are available for work of permanent improvement before the consecutive plan heretofore mentioned can be presented and considered, work should not therefore be delayed, but should continue as heretofore under projects for detached portions. In selecting points for improvement under such special projects, or under the general consecutive plan, those should first be chosen at which the greatest interference with navigation is experienced or threatened. At points where the channel

is at present comparatively good and permanent no attempt to confo to the standard channel should be made till other portions of the ri are under control.

In laying out a low-water channel, easy curves, passing into reve curves, should be adopted, and as far as possible the thread of the ri at high and low water should be made to coincide whenever this c be done without materially shortening the low-water channel.

The width of the low-water channel must be regulated by slope, curr discharge, and local circumstances, but it is believed that it should ne exceed 2,000 feet. The height of the dams should be that of medi water, thus bringing them into play before the low-water stage is reach The proper final width of channel and height of dams and dikes bei to a certain extent a question of experiment, their construction sho be gradual.

All duplicate channels and island chutes, outside of the propos final channel, should be closed by dams.

As far as possible all pushing dikes and spurs should be on the conv side, so as to throw the channel into the bends, and all caving banks the final channel, or of shores which are liable at high water to furni obstructing material, should be revetted.

The examination which the Board has just made of the Mississi River from Keokuk to Saint Louis has forcibly impressed upon th the importance of extending the district which now terminates at t mouth of the Illinois so as to include the stretch between the mou of the Illinois and Missouri rivers. The physical characteristics of t part of the Mississippi are identical with those of the river above mouth of the Illinois, whilst they are wholly different from those of t river between the mouths of the Missouri and Ohio, with which t stretch of river is officially connected. The plant and method of tre ment used on the district from Keokuk to Grafton is exactly adap to the river between Grafton and the mouth of the Missouri, while reverse is the case with the plant and method of treatment used bel the same point. Under these circumstances the Board believe that interests of the work would be best subserved by the transfer her suggested.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers, Bvt. Col., U. S. A
A. MACKENZIE,
Major of Engineers
A. M. MILLER,
Major of Engineers
WM. E. CRAIGHILL,
Second Lieut. of Engineers, Recorder

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX Y.

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND DES MOINES RAPIDS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—OPERATING AND CARE OF THE DES MOINES RAPIDS CANAL.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Upper Mississippi River, operations of snag-boats and dredge-boats.
2. Mississippi River from Des Moines Rapids to mouth of the Illinois River.
3. Mississippi River from Saint Paul to Des Moines Rapids.
4. Des Moines Rapids, Mississippi River.
5. Operating and care of Des Moines Rapids Canal.
6. Dry-dock at Des Moines Rapids Canal.
7. Ice-harbor at Dubuque, Iowa.
8. Harbors of refuge on Lake Pepin, at Lake City, Minnesota.
9. Harbors of refuge on Lake Pepin, at Stockholm, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 5, 1888.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Y 1.

OPERATIONS OF SNAG-BOATS IN IMPROVEMENT OF UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions; the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and exami-

nations in connection with new improvements, and for facilitating navigation through bridges, inspection and repair of existing works, formation of temporary or permanent channels through obstructing bars, and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi.

The plant used in connection with this work is the snag-boats and dredges. At times, when the plant is not required in connection with this special work, it is used under general or special appropriations for work of permanent construction.

The details of work accomplished during the past fiscal year, as well as much statistical information, are given in the appended reports of Assistant Engineer C. W. Durham.

It appears to be generally admitted that the preservation of the navigation of the Upper Mississippi is a necessity in the interest of cheap freight rates and for the benefit of the general public; and, in considering the importance of such work and the amount of good resulting therefrom, it seems proper to consider all freight affected by river competition rather than the amount of freight actually carried on the river. In connection with this subject I would refer to figures given in former annual reports, which show that the saving in cost of transportation by river as compared with transportation by rail, considering only freight carried by river, will amount in one year to as great a sum as has been expended to date for the improvement of navigation between Saint Paul and the Des Moines Rapids, a distance of over 500 miles. If amounts equal to the actual saving in cost of transportation, due to the existence of the river in its natural condition, were applied to its improvement for a few years, a permanent, easily navigable, low-water channel could be established. The average expenditure for the improvement of the Upper Mississippi during the past ten years has been less than 5 per cent. of the annual credit due the river as saving to interests of navigation, considering only freight actually moved by the river. As improvements are carried out the amount of saving increases.

There was but the sum of $4,588.63 available for the work of the snag-boats at the beginning of the fiscal year, and it was necessary to make a small allotment from the general appropriation.

In July and parts of August and September, 1887, the snag-boat *General Barnard* was engaged in the work of removing snags between Saint Paul and the mouth of the Missouri. When not so employed, the boat was either out of commission or in use as a tow-boat in connection with construction work. The system of using the snag-boat as quarters and transferring the crew to construction duty, during a portion of the year, after necessary snagging trips have been made, has worked admirably, resulting not only in efficient and economical construction work but also in keeping up, at but slight cost, the crew organization and in being prepared at all times for any snagging or similar work which may be called for in an emergency. October 9, 1887, the *Barnard* was laid up for the winter in the canal at Keokuk. In June, 1888, the boat was taken to Fountain City, Wis.

The snag-boat *J. G. Parke* was in use during past year as a tender to United States dredge, in connection with the construction of a "harbor of refuge on Lake Pepin, at Lake City, Minn."

A circular letter, dated Office Chief of Engineers, April 25, 1888, called attention to the necessity of establishing uniform high-water grade lines upon certain rivers over which bridges are, or may be, constructed under authority of Congress; and directed that the necessary information for establishing such grades be obtained. The very high

stage of water occurring on the Upper Mississippi in May, 1888, made the time a favorable one for establishing high-water marks and benches along the river, and a party was sent into the field for this purpose. The work was carried on under appropriation for "improving Mississippi River between Saint Paul and Des Moines Rapids," between Saint Paul and Keokuk, and under appropriation for "improving Upper Mississippi River," between Keokuk and the mouth of the Missouri River. High-water marks were established at all cities and towns and cut in the piers of the various bridges. The operations of the party are set forth in the appended report of Assistant Engineer C. W. Durham. The results accomplished and recommendations regarding the proposed grade line will be made the subject of a special report, to be submitted at a later day.

The most serious obstructions to navigation on the Upper Mississippi are the many bridges over it. There are now twenty-one bridges between Saint Paul and Saint Louis and about as many more are authorized. All of these bridges cause delay, and the passage of many is far from being safe or convenient. Much work has been done under section 8 of the river and harbor act of July 5, 1884; but some of the work was not properly done, more thought apparently being given to the question of cost than that of safety and ease of navigation. As a rule, willingness is expressed by bridge companies to do work and make changes when experience shows the same to be necessary; but the work is so much in the nature of experiment, and changes are made so deliberately, that they seem intended for future rather than present interests of navigation. Additional legislation is much desired which will fix more definitely upon bridge companies responsibility for the expense attending delays and injury resulting from failure to make approaches to and passage through or under bridges safe and convenient; and also which ill fix penalties for delay in carrying out necessary work. It is also most desirable that there be enacted a general bridge law for the Upper Mississippi, containing all the reasonable restrictions demanded by the interests of navigation, and prohibiting the construction of all bridges except in accordance with such law. Such a law should be substituted for the many acts now in force but not yet taken advantage of.

The work of the snag and dredge boats is an important one, furnishing immediate results and benefiting especially present interests of navigation.

From the nature of this work, it is impracticable to carry it out by contract.

As stated in my last three annual reports—

> I believe that permanent provision should be made for this work of snagging, wrecking, tree cutting and pulling, clearing banks, finding and marking new channels, making surveys, soundings and examinations, assisting boats in distress, watching and repairing existing improvements, investigating and supervising work on bridges, collecting physical data and statistics of commerce and navigation, and, in general, facilitating and reducing expenses of navigation.

To carry on this work properly, including the operation of a dredge, would cost approximately $30,000 per year, and, in my opinion, the work should be placed on the same footing as the canals now operated by the Government in accordance with the provisions of the act of Congress of March 3, 1881.

An appropriation of $30,000 is recommended for the next fiscal year. This estimate is based on necessary operating expenses and can not be reduced without affecting efficiency of work.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867	$96
By allotment from appropriation of July 25, 1868	26
By allotment from appropriation of 1869	35
By act approved—	
July 11, 1870	36
March 3, 1871	42
June 10, 1872	42
March 3, 1873	25
June 23, 1874	25
March 3, 1875	25
August 14, 1876	30
June 18, 1878	4[illegible]
March 3, 1879	2[illegible]
June 14, 1880	[illegible]
March 3, 1881	2[illegible]
By act passed August 2, 1882	2[illegible]
By act approved August 5, 1886	2[illegible]
Total	524

Money statement.

July 1, 1887, amount available	$4,588
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,677
July 1, 1888, balance available	1,911
Amount appropriated by act of August 11, 1888	25,000
Amount available for fiscal year ending June 30, 1889	26,911
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 18[illegible]

MAJOR: I have the honor to present my Annual Report on improving Upper Mi sippi River for the fiscal year ending June 30, 1888, together with some statisti commerce and navigation.

OPERATIONS OF SNAG-BOAT GENERAL BARNARD.

Details of operations of the *Barnard* prior to July 1, 1887, were given in my Annual Report. On that date the *Barnard* was at work at Whitney's Bar, abo miles below Quincy, Ill. Arrived at Keokuk on evening of July 2. From point she proceded up river, removing obstructions on the way, and reached I man's Landing July 14. Taking a tow of barges at this point she went o river, arriving at Fountain City on July 17. At Fountain City the barges were and she arrived at Saint Paul July 19. During the remainder of the month obs tions were removed from the river between Saint Paul and Fountain City. O trip above mentioned work in removing snags, leaning trees, etc., was performed near Whitney's Bar, Marion City, Cottonwood Island, Canton, Island 414, and C Landing below Keokuk; and between that point and Saint Paul, at or near D Island, Shokokon, Sauerwein's Bend, Burlington, Henderson River, Benton Isl Thieves Island, Edwards River, Port Louisa, Hershey Boom, Sabula, Santa Fé, old's, Green Island, Gordon's Ferry, Nine Mile Island, Maquoketa Slough, McMil Island, Wyalusing, Picayune Chute, Dresbach Island, West Newton, Pine I Bend, Beef Slough, Crat's Island, Red Wing, Diamond Bluff, Newport, and Merri From August 1 to 10 the *Barnard* was out of commission, lying near Chimney and being used as quarters for men employed in construction of dams and shore tections. The river becoming low and many snags reported, it was decided to another snagging trip. The boat left for below August 10, arriving at Saint I

on the 20th. Returning from that point on the 22d, she arrived at Fountain City September 11 and lay up. On this trip work was performed at or near Richmond, La Crosse, Picayune Chute, Turkey River, Sand Prairie, Dark Slough, Cordova, Port Louisa, Edwards River, New Boston, Benton Island, Burlington, Nigger Chute, Lone Tree Prairie, Cottonwood Island, Quincy, Fabius Island, Blackbird Island, Hickory Chute, Enterprise Island, Mason Chute, Piasa Island, Squaw Island, Hatchet Chute, Point Landing, McCann's, Two Branch Island, Hat Island, Stag Island, Sterling, Hamburg, Mosier's, Tisdale Towhead, Bay Island, Amaranth Island, Hickory Chute, Hannibal, Turtle Island, Whitney's, Bludsoe's, Burlington Island, Keithsburgh Bridge, Dark Slough, Royal Arch, Maquoketa Slough, Bunker Chute, Glen Haven, Clayton, and Wyalusing. From September 12 to 26 the *Barnard* was out of commission, lying near Fountain City. From September 27 to October 13 she was employed on work of construction in vicinity of Alma, in towing rock from Fountain City. October 13 and 14, towed fleet to Heytman's Landing. October 15 to 29 lay up at Heytman's Landing. October 30 to November 4, made a tripto Lake City and brought down six dump-boats, which were placed in harbor at Heytman's. On November 9 was laid up in canal above Keokuk, where she remained during the winter. The river being so high in the spring of 1888, it was not considered advantageous to put her in commission for snagging purposes; but early in June she came out of winter quarters and proceeded to Fountain City, Wis., where she was laid up and used as quarters for men employed on the work in that vicinity.

Summary of operations of snag-boat General Barnard for fiscal year ending June 30, 1888.

Snags removed	232
Leaning trees pulled back	29
Leaning trees felled and removed	853
Wrecks removed	3
Miles run	5,536

The *Barnard* was in snagging commission during the fiscal year fifty-six days.

Expenditure during fiscal year on snag-boat General Barnard.

From Saint Paul to Des Moines Rapids appropriation	$5,742.63
From Upper Mississippi River appropriation	2,285.88
Total	8,028.51

OPERATIONS OF SNAG-BOAT J. G. PARKE.

The snag-boat *J. G. Parke* was used in 1887 in connection with dredge *Phœnix* in the construction of breakwater at Lake City, Minn.

I gave in my report for 1884 a summary of the snag-boat service on the Upper Mississippi River from 1868 to 1884, inclusive (calendar years). There follows a table showing the work of the *Barnard* during the seasons of 1885, 1886, and 1887.

Improving Upper Mississippi River. Summary of operations of snag-boats from 1885 *to* 1887, *inclusive* (*calendar years*).

Year.	Snag-boat.	Snags removed.	Leaning trees felled and removed.	Leaning trees pulled back.	Steamboats, etc., assisted.	Miles run.	Remarks.
1885	Barnard	45	378	8	.....	1,829	Only forty days in snagging commission on account of lack of funds.
1886	Barnard	165	676	14	1	2,101	Only thirty-seven days in snagging commission. *Barnard* repaired in winter at Dubuque and *J. G. Parke* at Rock Island.
1887	Barnard	341	1,485	44	1	7,779	Wrecks removed, three. In snagging commission fifty-six days.
Total, 1885–'87.		551	2,539	66	2	11,709	
Total, 1868–'84.		4,875	29,644	434	129	65,033	
Grand total, 1868–'87.		5,426	32,183	500	131	76,742	

In addition to above, the *Barnard* in 1881, in Cuivre River, pulled 94 snags and 30 impending trees, and cut and removed 13,485 trees.

RIVER NOTES.

During the spring and early summer of 1887 the river was at a fair boating stage, but no high water occurred. By the latter part of June it had fallen to a low stage and remained unusually low during the remainder of the season from Saint Paul to the mouth of the Missouri. In August, at many points for several days, the gauges showed less than 1 foot above low water of 1864. The river below Keokuk was in bad condition, in fact much worse than the river above, so that the regular Keokuk and Saint Louis line packets were obliged to stop running. Above Keokuk, except at a few points, the boats had little difficulty, and packets went through to Saint Paul during the entire season. The extreme low water made apparent the advantages of the improvements already completed at many points, and especially in that portion of the river between Saint Paul and Hastings, at Beef Slough, Crooked Slough, Betsy Slough, and other localities. In 1888 the river has continued high to present date. In April and May it attained a height at some points greater than that of 1880 and 1881, both very high-water years.

I give a list of channel depths, in feet, on some of the worst bars at the low-water period of 1887: Frenchman's, 3; Pig's Eye, 4; Red Rock, 3; Merrimac, 3.5; Robinson's, 3.5; Island No. 15, 4; Nininger Slough, 3.5; Read's Landing (below), 3.5; Wabasha, 3.3; Beef Slough, 3.5; West Newton, 3; Fountain City, 3.5; Wild's, 4; Winona (above), 4; Winona (below), 3.3; Eastmoor, 3.5; Richmond, 3.5; Dakota, 3.3; Dresbach, 4; Root River, 4; Crooked Slough, 3.5; Galena River, 3; Bellevue, 4; Keller's, 4; Hershey Boom, 3; Muscatine, 3.5; Thieves Island, 3.5; Skunk River, 4; Shokokon (foot), 4; Island No. 385, 3.5; Pontoosac, 3.5; Devil's Island, 3.5; La Grange (below), 4; Lone Tree, 4; Fabius Island, 3.5; Marion City, 3.3; Whitney's, 3.5; Turtle Island, 4; Cincinnati Landing, 4; Red's Landing, 3.5; Sterling Island, 4.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business connected with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1887 to about 100 raft-boats, valued at $750,000. Between Saint Paul and Saint Louis 74 saw-mills were operated by 63 wholesale lumber firms, having an invested capital of $35,000,000. Their manufactures in 1887 were: Lumber, 988,361,094 feet B. M.; shingles, 363,239,750. In addition to the manufacturers there are large numbers of retail or distributing firms scattered along the river. The business of 1887 was not as large as in some former years, owing to low water.

Steam-boats and freight.—The principal steam-boat lines on the Upper Mississippi River are the Saint Louis and Saint Paul Packet Company, the Diamond Jo Line, and the Eagle Packet Company. There are also many independent boats carrying freight and passengers. During 1887 the amount of freight carried was 1,352,638 tons, and the number of passengers carried, including those of ferry and excursion boats, was about 800,000.

Statement of amount of freight received and shipped from Saint Louis by the Upper Mississippi for five years.

	1887.	1886.	1885.	1884.	1883.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received	132,400	140,880	117,445	129,895	126,330
Shipped	36,170	46,190	48,295	43,110	60,020
Total	168,570	187,070	165,740	173,005	186,350

1887.

Steam-boats and barges from Upper Mississippi arrived at Saint Louis	1,106
Tons of lumber and logs received at Saint Louis from Upper Mississippi River by raft	213,165
Steam-boats and barges departed from Saint Louis for Upper Mississippi River	1,076

Receipts of lumber, logs, etc., at Saint Louis from Upper Mississippi during 1886 *and* 1887.

Articles.		1887.	1886.
White-pine lumber	Feet	136,490,066	124,154,170
Cotton-wood lumber	do	6,436,000	3,925,500
Total	do	142,926,066	128,079,670
Shingles	Number	70,370,735	48,483,000
Laths	do	43,034,705	37,154,600
Pickets	do	448,060	862,330
Total	do	113,853,500	86,499,930

Receipts and shipments of flour, grain, and provisions by Upper Mississippi River boats in 1887.—*Port of Saint Louis.*

	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.	Pork.	Hams.	Meats.	Lard.
	Bbls.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bbls.*	*Lbs.*	*Lbs.*	*Lbs.*
Receipts	65,708	689,505	180,595	457,520	9,965	16,291	685	47,600	91,510	28,980
Shipments	1,567	.....	435	1,420	.....	.....	82	30,388	16,614	29,484
Total	67,275	689,505	181,030	458,940	9,965	16,291	767	77,988	108,124	58,464

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Statement of steamers, barges, and rafts passing various bridges.

Locality of bridge.	Steam-boats.			Barges.			Rafts.		
	1887.	1886.	1885.	1887.	1886.	1885.	1887.	1886.	1885.
Hastings	805	820	1,009	971	909	1,316	26	25	4
Winona	4,300	4,570	5,126	1,600	974	848	1,100	1,860	1,973
La Crosse	4,213	4,347	4,775	578	587	475	1,451	1,485	1,797
Dubuque	6,088	4,766	3,561	1,107	1,221	626	841	728	882
Sabula	3,049	1,912	2,180	(*)	1,110	934	(*)	†23	(*)
Clinton	2,753	2,993	2,631	650	623	618	†564	†543	†313
Rock Island	2,660	2,393	2,331	271	139	153	774	784	747
Burlington	1,658	1,558	1,562	312	312	319	291	(*)	(*)
Keokuk	1,618	1,380	1,711	808	398	1,538	244	229	237
Quincy	1,959	1,708	1,509	829	770	602	311	291	298
Hannibal	1,551	1,515	2,135	516	494	458	(*)	(*)	(*)
Louisiana	1,036	1,082	1,092	494	463	374	98	96	98

* No record. † Partial record.

Customs revenue and tonnage for the year ending December 31, 1887.

Port.	Collections.	Tonnage enrolled.	Vessels.
Saint Louis, Mo.*	$1,414,747.99	146,178.54	243
Burlington, Iowa	15.45	5,175.82	51
Dubuque, Iowa	1,193.67	4,312.44	20
La Crosse, Wis	8.01	4,195.64	51
Galena, Ill	1.00	3,005.26	24
Saint Paul, Minn	875,027.51	3,287.88	41
Total	2,290,993.63	167,155.58	430

* Only a part of the Saint Louis statement applicable.

Internal revenue for the year ending December 31, 1887.

District.	Office.	Amount.
Minnesota	Saint Paul	$546, 53[illegible]
Second Wisconsin	Madison	373, 75[illegible]
Third Iowa	Dubuque	182, 55[illegible]
Fourth Iowa	Burlington	904, 61[illegible]
Fifth Illinois	Peoria	16, 418, 40[illegible]
Aggregate		18, 425, 887.

List of wrecks between Saint Louis and Saint Paul which are or may become obstructions to navigation.

Name.	Place.	Name.	Place.
Baltimore	In bar at Montgomery's Tow-head.	Barge	At the bank just above slaugh ter-house below Clarksville.
Altona	In bar at Montgomery's Tow-head.	Unknown	Opposite creek above Clark ville, in mid-stream.
Badger State	In bar at Montgomery's Tow-head.	Atlas	Near head of Atlas Island.
Cornelia	Head of Sawyer Bend.	Denmark	Near head of Atlas Island.
Barge	In crossing below Madison, Ill.	Dubuque	Above Mundy's Landing.
America	Opposite Madison, Ill.	Dictator	Opposite Hannibal.
Reindeer	Below mouth of Wood River.	Lucy May	Below La Grange.
Barge	At mouth of Wood River.	Brownsville	In Brownsville Chute.
Unknown	Foot of Maple Island.	Wyman X	Below Fort Madison.
Unknown	Foot of Alton Island.	Prairie Bird	One mile above Keithsburg Bridge.
Unknown	Opposite Wilson's Island.	Pike	On point (main shore) in san bar opposite Sinope.
Flat-boat	Below Piasa Chute.	Dr. Franklin	Foot of Maquoketa Chute.
Barge	Below Jersey Landing.	Barge	Above Clayton.
Heilman	Half way between Missouri Point and second ravine below Grafton.	Menominee	Below Britt's Landing, ne shore.
Archer	In chute between Island 521 and Island 522.	Lady Franklin	Below Britt's Landing, ne shore.
Enterprise	In chute between Island 521 and Island 522.	Barge	In crossing above Brownsvill Wis.
Chapman	In chute between Island 521 and Island 522.	Barge	Head of Picayune Island.
Barge	Head of Iowa Island.	J. W. Wilson	On shore opposite Dakota.
Golden Eagle	Opposite Martin's Landing.	Argo	Above Winona.
Mollie McPike	Carrol's Field.	Barge	Above Diamond Bluff (midd crossing), on shore.
Sarah Ann	Head of island 500.	Barge	Mouth of Big River (abo Smith's Landing).
Highland Mary	Below foot of Thomas Chute.		
Ferry-boat	In bar abreast of Island 465.		

Locations of rocks which are or may become obstructions to navigation.

At the chain above Saint Louis.
In Piasa Chute.
Piasa Dam.
Below Salt River.
In channel opposite foot of Island 420.
Below La Grange.
Near shore above La Grange.
In crossing at Gregory's Landing.
At Des Moines Rapids.
At Devil's Island, above Nauvoo, in the crossing.
Rock bottom above Nauvoo Landing.
At Pontoosac and foot of Dallas Chute.
In main river opposite and below Dallas.
Above Burlington, at Drew's Prairie.
On head of Otter Island and above.
At and below Oquawka.
Below New Boston, extending from Illinois shor
Below Keithsburgh, in main river and at foot chute.
Above Muscatine.
At Fairport.
At Montpelier.
First island below Buffalo.
Near shore at Buffalo.
At Horse Island.
At Rock Island Rapids.
In crossing below Cordova (may be gravel).
Above Reed's Landing, foot of Lake Pepin.
Bowlder reef below Diamond Bluff.
At Grey Cloud.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., June 4, 1888.

MAJOR: I have the honor to present a preliminary report on the establishment of high-water grade lines on the Upper Mississippi River from Saint Paul to the mouth of the Missouri River.

ESTABLISHING HIGH-WATER GRADES.

In accordance with your instructions, a party was put in the field on the 1st of May, 1888, for the purpose of ascertaining and marking, at numerous and convenient points along the river, authentic high-water planes, as having an important bearing upon the location and height of bridges to be hereafter constructed across the Upper Mississippi River. I was also directed to examine old bench-marks, to establish new ones, to ascertain the elevations of existing bridges, and to obtain information in general in regard to the height and duration of floods, etc.

The party left Keokuk on the tow-boat *Fury*, May 2, and working up-stream, laboring under many disadvantages from rain and wind, arrived at Saint Paul on May 14; thence, returning and performing such work as was omitted on the up trip, reached Keokuk on May 24. The party was then transferred to the snag-boat *J. G. Parke*, and made the trip to Saint Louis and return by May 31. The very high stage of water prevailing during the time of the work, it being at some points the highest of recent years, was, on some accounts, advantageous; but there were many drawbacks attached to it, the difficulty of finding our old bench-marks, most of which were submerged, being the chief of them. At most of the cities, towns, and landings, which are generally located on high ground, no difficulty was experienced in referring the high-water marks to our line of levels by means of the old bench-marks; but even at some of these places no bench-marks above water were in existence, and new ones, of arbitrary elevations, were established, to which the high-water marks were referred, and which it is expected to connect with our level lines at an early date. * * *

From Saint Paul to Keokuk, high-water and bench marks were established at Saint Paul, Hastings, Red Wing, Read's Landing, Wabasha, Alma, Minneiska, Fountain City, Winona, La Crosse Bridge, Brownsville, Bad Axe, Lansing, Lynxville, Prairie du Chien, Clayton, Glen Haven, Cassville, Specht's Ferry, East Dubuque, Dubuque Railroad Bridge, Dubuque, Bellevue, Clinton, Albany, Sabula, Le Claire, Fairport, Muscatine, Keithsburgh, New Boston, Oquawka, Burlington, Burlington Bridge, and Fort Madison.

From Keokuk to Alton, high-water and bench marks were established at Warsaw, Alexandria, Canton, La Grange, Quincy Bridge, Quincy, Hannibal Bridge, Hannibal, Gilbert's Chute, Louisiana, Clarksville, Hamburgh, Hastings Landing, Dixon's Landing, Grafton, Jersey Landing, and Alton. The elevations of the bottom chords of the draw or main spans of all the bridges were also taken.

So many of my high-water marks being referred to arbitrary elevations, and there being many additional points at which it would be desirable to have high-water marks, which time, the high water itself, and storms prevented me from establishing, and as I expect during the present working season to supply the deficiencies incidentally while engaged on other work, and thus obtain all the data needed for a full and comprehensive profile and discussion of the high-water grade-lines, I postpone the submission of a final report until later in the season.

The cost of the field work amounts to $1,560.90, of which $1,169.49 was paid from appropriation for "improving Mississippi River from Saint Paul to Des Moines Rapids" and $391.41 from appropriation for "improving Upper Mississippi River."

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 2.

IMPROVING MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO THE MOUTH OF THE ILLINOIS RIVER, ILLINOIS AND MISSOURI.

In February, 1888, the funds available under this title of appropriation were temporarily transferred to me for disbursement during the absence on leave of Capt. E. H. Ruffner, Corps of Engineers.

No field work was carried on, the only employés being watchmen caring for plant.

In April, 1888, upon the return of Captain Ruffner to duty, the balance of funds was returned to him.

Money statement.

February 16, 1888, amount received from Capt. E. H. Ruffner, Corps of Engineers		$1,488.39
Received from sale of fuel		11.25
Total		1,499.64
Amount expended	$434.05	
April 23, 1888, amount transferred to Capt. E. H. Ruffner, Corps of Engineers	1,065.59	
		1,499.64

Y 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM SAINT PAUL TO DES MOINES RAPIDS.

Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in constructions of rock, brush, piles, and gravel, which close side chutes and reduce the low-water channel to a proper width, and in the protection of caving banks. The appropriation also provides for a certain amount of dredging and other temporary work for the more immediate and rapid removal of obstructions to navigation.

During the past fiscal year work of permanent improvement was carried on under a project submitted February 11, 1887, by days' labor, between Saint Paul and Hastings, in vicinity of Crooked Slough, between Read's Landing and Winona, on Rock Island Rapids, and between Otter Island and Nauvoo, and by contract between Homer and Queen's Bluff, Guttenberg, and Waupeton, and Sand Prairie and Savanna. Temporary work of dredging, etc., was carried out at numerous points.

The details of all this work are given in the appended reports of Assistant Engineer C. W. Durham, and United States Civil Engineer M. Meigs. These detailed subreports are given for the calendar year ending December 31, 1887, a general description of the operations of the latter half of the fiscal year being given in separate reports. It is proposed to follow this system hereafter, as it permits the preparation of more detailed reports of operations and cost than can be hurriedly prepared at the close of a fiscal year while work is actually in progress.

The only fund available for work during the past year was the balance remaining unexpended from the appropriation of August 5, 1886, and as work was required at numerous localities, it was impossible to operate to as great an advantage as if larger allotments could have been made; but all the work carried out gave most beneficial results, and the action of the former work continued to improve and deepen the channel at points where formerly serious obstructions existed.

The section of the river between Saint Paul and the mouth of the Saint Croix (Prescott) is now well under control, and plans and estimates have been prepared for completing work in this locality. Such work, it is an-

ticipated, will, if funds are available, occupy two seasons. The plans for the improved river above the mouth of the Saint Croix contemplate a channel 400 feet wide and 6 feet deep at low water. The height of dams is such as to secure the scouring effect of the current at a 4-foot stage. The width chosen is desirable for purposes of navigation, but it is not certain the same can be maintained. It is anticipated that in portions of this section, especially its upper end, to secure and maintain the full depth, a further reduction of width may ultimately be necessary.

On sections of the river below the Saint Croix, to secure uniform work, which eventually will be a part of a continued system, probable widths of channel and general plans have been fully considered, but no consecutive detailed plans or estimates have been prepared. The immediately necessary work on these sections is detached, and projects are confined to the special localities where funds permit and the necessities of commerce require improvements to be carried out.

The project of February 11, 1887, for the expenditure of the available balance was abandoned in April, 1888, and a new project, covering a portion of the balance, was submitted and approved. Until additional funds become available work must be confined to surveys, repairs, and such limited constructions as are imperatively necessary and permissible. When a new appropriation becomes available, the construction of closing and spur-dams and shore protections at points where trouble is liable to be experienced will be continued, as in former seasons.

SURVEYS AND GAUGES.

During the year, as heretofore, a number of gauges have been kept up and daily readings taken.

Numerous surveys and examinations were made in connection with construction work.

On April 6, 1888, authority was obtained to make a number of surveys at points where improvements were considered necessary. A survey from Fairport to Muscatine was made in April, 1888, but other surveys have been delayed by the extreme high stage of the river. In June a survey from Read's Landing to Alma was commenced.

During May a party was engaged in establishing and permanently marking high water at various localities. This work is referred to in more detail under title of "Improving Upper Mississippi River."

BUOYS ON ROCK ISLAND RAPIDS.

During the year, as heretofore, buoys have been maintained on Rock Island Rapids and have been of great service to the interests of navigation. A full account of this work is given in the report of Assistant Engineer C. W. Durham.

SNAG-BOAT.

A small allotment was made from the general appropriation for the operations of the snag-boat *General Barnard*. These operations are described in report for "Improving Upper Mississippi River."

FACILITATING NAVIGATION THROUGH BRIDGES OVER THE UPPER MISSISSIPPI RIVER, BETWEEN SAINT PAUL AND KEOKUK, UNDER SECTION 8, RIVER AND HARBOR ACT OF JULY 5, 1884.

During the past year the Highway Bridge at Dubuque, Iowa, was completed. This bridge was commenced without authority of Congress, but, by act of February 21, 1887, the construction was authorized, pro-

vided it was decided by the Secretary of War that the wagon-bridge was no substantial obstruction to navigation. The plans of the bridge, as built, were approved by the Secretary of War. Some short booms, connecting the piers of this bridge with the Railroad Bridge, are necessary and will be required.

A railroad bridge at Fort Madison, Iowa, built under act of Congress approved May 25, 1872, was also completed during the year. A sheer-boom 1,000 feet long was placed above the draw; but, so far, this boom has not proved very effectual and must be materially changed. After completion of this bridge it was discovered that certain brackets for carrying a wagon-way projected over the draw-openings and endangered navigation. The bridge company have agreed to remove the danger by placing substantial floating booms outside of the long pier. This is practicable without reducing the draw-openings to the limit prescribed by law.

Some difficulty having been experienced by rafts in passing the pile and ponton bridge at McGregor, plans contemplating a change in location of bridge were suggested by the owner of the bridge, and approved by the Secretary of War. The change is now being made and it is thought the McGregor Bridge, in it new location, will be the least obstructive of any bridge on the Upper Mississippi.

The guard-fence above the Keithburgh Bridge was materially injured by the ice in the spring. Repairs were commenced, but delayed by high water. An endeavor has been made to have the faulty location, originally given this fence corrected; but it is not yet determined whether or not the bridge company will voluntarily do the desired work.

An additional boom, 400 feet in length, was built for the Burlington Bridge during the winter; but, at the request of the raftsmen, the placing of this boom has been delayed till after the extreme high-water stage has passed by.

A high bridge was completed at Saint Paul (Robert Street Bridge) during the year. The main span of this bridge covers the entire channel, but in other respects it does not fully comply with the law under which it was built. It does not, though, materially obstruct navigation.

Some work for facilitaing navigation has been carried out at most of the bridges between Saint Paul and Keokuk, and in the majority of cases navigation has been made much easier. At some points additional work will be required and at others faults in orighal construction and local conditions render it impossible to do much for the interests of navigation under present laws.

Some work is much needed for rendering more safe the passage through the dangerous bridge at Keokuk. It is hoped that some desired legislation will soon permit the necessary work to be carried out at this point.

During the extreme high water of the past spring measurements have been taken at most of the bridges to determine accurately their height above high water. It is found that for many of the bridges, built under laws which did not require proper supervision, the heights are not in accordance with law or sufficient for purposes of navigation; but, as all the bridges referred to are provided with draws, the height is not of as great importance as in the case of high bridges without draws.

COST OF WORK.

During the calendar year ending December 31, 1887, 75,381.6 cubic yards of material were put into dams and shore protections by contract

at a total cost of $86,269.86, or $1.144 per cubic yard; 122,137 cubic yards of material were put in by days' labor and Government plant at a total cost of $123,606.65, or $.1012 per cubic yard. The cost of days' labor work includes a charge of $17,640.65 for the use of Government plant, and also includes the profit to contractors for brush and rock, all of which was purchased by contract or in open market. The figures here given indicate a saving to the Government as a result of days' labor work of 13.2 cents per cubic yard, or in all, $16,122.08. This saving, together with the amount charged to the works for the use of plant, amounts to $33,762.73, which can be considered as a credit for the year, in connection with construction work, to the general item of cost of plant.

There was an additional credit to cost of plant in the form of charge against work of dredging and buoys, $888.55. The credit due to saving on this class of work, though large, has not been taken into account.

During the eight years preceding December 31, 1887, 223,542.83 cubic yards of material were put in dams and shore protections by contract at a total cost of $280,989.94, or $1.257 per cubic yard. During the same time there were put in by days' labor and Government plant 583,445.88 cubic yards, at a total cost of $692,635.34, or $1.187 per cubic yard. The cost of days' labor work includes a charge of $113,521.99 for the use of Government plant, and also includes profit to contractors for material purchased by contract and in open market. The figures given indicate a saving on field-work, due to the use of Government plant, of $40,841.21, giving as the actual credit to the item of cost of plant, in connection with construction work, during the eight years, of $154,363.20.

The credit to plant for charges against dredging and other work, not considered in above statement, during the eight years is $6,251.15. The saving in connection with the use of Government plant for this class of work, though large, is, as in case of calendar year, not considered.

The total expenditure for plant, including original purchase and repair and care up to December 31, 1887, was $193,889.96. The credit to cost of plant resulting from charges made against work, as deterioration of plant, and included in figures here given, amounts for dams and shore protections and other work as enumerated to $119,773.14, giving as an estimated value of plant to the United States, December 31, 1887, of $74,116.82. Deducting from this figure the saving due to use of plant, $40,841.21, the actual cost of plant to the United States on December 31, 1887, is further reduced to $33,275.61.

When the work of permanent improvement of the Upper Mississippi was inaugurated about nine years ago, it was found that the building up of a plant by the United States was an absolute necessity. There were few suitable boats and barges in the hands of private parties and but very few contractors were able to undertake the work. It is now a satisfaction to know that the large and effective plant collected during the past eight years has been almost paid for by the saving it has effected.

The comparison of cost of work carried out by contract and by days' labor is even more favorable to the latter than the figures given would indicate. In deciding upon work to be let by contract it is necessary to select points where work is concentrated and comparatively definite in character and amount, so that proper specifications can be drawn. The work carried out by aid of Government plant, on the contrary, is usually of the indefinite class determined on as circumstances require; often it is in the nature of repairs and small in amount in any one locality; often widely scattered, requiring frequent moving of large fleets

and towing of material long distances under disadvantageous circumstances.

Material, such as rock and brush, has in the past been purchased at times by formal contract, but as a rule in open market by informal agreement with all parties desiring to furnish material at reasonable rates. The latter method has proved most advantageous both as regards price and rate of delivery. The economy of work requires not only that material be obtained at reasonable rates but that it be furnished promptly and in such quantities as will keep working parties fully employed, and prevent expensive delays. Experience has shown that to secure such supplies arrangements for delivery must be made with a number of parties at numerous points, and that, in estimating probable rate of delivery, all promises must be discounted.

As furnishing evidence of the advantage of purchases of material in open market under informal agreement the following examples are given:

Between Saint Paul and Hastings, previous to 1884, all rock was purchased in open market at rates, depending on locality and difficulty of quarrying, varying from 59 to 63.3 cents per cubic yard loaded on United States barges. In 1884 bids were received for furnishing 10,000 cubic yards of rock on barges, prices offered ranging from 69 to 74½ cents. The bids were all rejected and rock was purchased in open market of the same parties at rates of from 52.7 to 58 cents per cubic yard. In 1885 bids were again received, the lowest price offered, considering tow, being 61½ cents; other bids ranged from 87 cents to $1.75. All bids were rejected and rock was purchased in open market at convenient points at 57 and 58 cents per cubic yard. Since 1885 the making of formal contracts for rock on the upper portion of the river has not been attempted, stone having been purchased in open market at prices ranging as a rule from 52¾ to 57 cents per cubic yard.

At Stockholm, on Lake Pepin, the price paid for rock put in cribs under formal contract was $1 per cubic yard. For the work at Lake City, under similar circumstances, a large amount of rock was purchased on barges at rates of from 63 to 68 cents per cubic yard, and some rock was delivered on barges at the work at prices ranging from 52 to 63 cents. Allowing a liberal cost for towing and placing in cribs, the open market figures are much lower than the contract.

Rock was purchased in open market at Alma, Wis., in 1882 at the rate of 73.8 cents per cubic yard, and in 1884 at the rate of 65 cents, loaded on barges. Bids were received in 1887 for rock on bank at Alma, the prices offered ranging from 80 cents to $1.25. All were rejected and rock was purchased at the same point at a rate of 73.7 cents on barges.

In 1884 10,000 cubic yards of rock were purchased under formal contract near Winona, Minn., at rate of 65 cents per cubic yard on United States barges. During the same season rock was subsequently purchased in open market in same locality at the rate of 63½ cents per cubic yard.

In 1885 bids were received for furnishing rock on barges between Read's Landing and Winona. The only bid received was at the rate of $1.75 per cubic yard. This was rejected, being more than two and one-half times the price for which rock could be purchased in open market.

In 1885 bids were received for rock on bank at Crooked Slough and other points. The lowest price for Crooked Slough was 65 cents per cubic yard on the bank; other bids ranged from 79 cents to $1.80. All were rejected. In 1887 large quantities of rock were purchased in open market near Crooked Slough at the rate of 52½ cents on the bank *or 67½ cents loaded* on barges.

In 1885 bids were received for furnishing rock on barges between Rock Island and Montrose. The lowest bid offered was 48½ cents, which was accepted. This especially low figure was the result of a desire on the part of the owners of a quarry to rid themselves of certain refuse. Other bids ranged from 59 cents to $3.25 per cubic yard. Certain parties in Nauvoo, who bid 59½ cents, furnished the same rock subsequently for 52¾ cents.

In 1887 bids were received for delivering rock on barges between Fountain City and Winona. The lowest price offered was 75 cents. This bid did not appear so great as to justify its rejection; but subsequently it was discovered the same rock could probably have been purchased in open market for 65 cents, and rock is now being furnished by the same party in same locality under open market purchase at rate of 64½ cents per cubic yard.

Only one purchase of brush has been made by formal contract, the price paid being 34 cents per cubic yard loaded on barges between Saint Paul and Hastings. Since the close of the contract such brush has been purchased in the same locality at from 28½ to 33½ cents, and purchases have been made at other points for 25 and 28 cents per cubic yard.

Many other cases might be enumerated, but those given will probably be sufficient to show that it is more economical and advantageous to the Government to purchase such material in open market than to purchase under formal contract, both as regards price and amount and rate of delivery.

My report for 1886 contained a table giving cost of materials furnished by contractors and bought in open market, from 1878 to 1885, inclusive. To carry the information up to the close of the working season of 1887 I give the following table:

Comparative cost of materials, 1886 *and* 1887.

Locality of delivery.	Rock (per cubic yard).			Brush (per cub. yd.).		Poles (each).
	In place.	On U. S. barge.	On bank.	In place.	On U. S. barge.	
1886.						
Pig's Eye Island to Grey Cloud					$0.34	$0.03½
Pig's Eye Island to Nininger					.34	.03½
Red Rock		$0.63 3/10				
Nininger		.53 8/10				
Newport		.57				
Crooked Slough		.75			.28	.02½
Chimney Rock	$1.00					
Nauvoo			$0.52¾			
1887.						
Merrimac		.57			.33½	.03
Nininger		.52¾				
Grey Cloud					.33½	.03
Hastings					.33½	.03
Smith's Bar					.28¾	.03½
Saint Paul to Nininger					.33½	.03
Below Prescott (4 miles)					.31½	.03½
Read's Landing		.63 3/10				
Lake City		.52 8/10	*.70			
Lake City		.63 3/10				
Stockholm		.63 3/10				
Smith's Cooley		.63 3/10				
Smith's Cooley		.52 8/10	*.21 1/10			
Roscoe Cooley		.68 8/10				
Alma		.73 7/10				
Chimney Rock		.70	.55			
Fountain City	1.00	.75			.28	.02½

Comparative cost of materials, 1886 *and* 1887—Continued.

Locality of delivery.	Rock (per cubic yard).			Brush (per cub. yd.).		Poles (each).
	In place.	On U. S. barge.	On bank.	In place.	On U. S. barge.	
1887.						
Van Gorders		$0.75				
Homer to Queen's Bluff	$1.53			$0.73		
Lansing		.67½	$0.52½			
Heytman's Landing		.67½	.52½			
Lynxville		.67½	.52½			
Guttenberg to Waupeton	1.00			1.00		
Guttenberg to Waupeton	.95			.70		
Sand Prairie to Savanna	1.30			.70		
Buffalo		.71				
Buffalo		.65				
Buffalo		.68				
Nauvoo			.48			
Dallas					$0.28	$0.02½

[a] Very small quantity.

IMPROVEMENT OF HARBOR AT LAKE CITY, MINNESOTA.

The river and harbor act of July 5, 1884, provided, under a separate item, for continuing work on the harbor of refuge at Lake City, but this item was taken up on the books of the Treasury Department as an allotment from the general appropriation for "Improving Mississippi River from Saint Paul to Des Moines Rapids." Of this special appropriation or allotment there remain available $3,014.77, which will be used for repair work. This item of appropriation is necessarily considered in abstract of appropriations and money statement under this head of report, but the record of operations at Lake City is given, as usual, under the special heading of "Harbors of refuge on Lake Pepin at Lake City, Minn."

THE ADAMS FLUME.

The act of Congress of August 5, 1886, provided that the "amount of $15,000, or so much thereof as may be necessary, may be used by the Secretary of War, in his discretion, for continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams."

My last annual report gave a brief summary of the operations of Mr. Adams in connection with the construction of an experimental flume, which, he claims, will, if ever brought to a practical test, prove useful for improving river channels.

In July, 1887, Mr. Adams was nominally at work under an authority of the Secretary of War which restricted his operations to such as were "absolutely necessary to placing in the water and practically testing the portion of the flume completed." Previous to this time Mr. Adams had reported to Congress that 1 mile of his flume was complete and ready to test. A general supervision of the work was intrusted to me by an indorsement of the Secretary of War which provided that "Major Mackenzie should be directed to inspect the work done under the direction of Mr. M. J. Adams as often as may be necessary, and all vouchers and bills will be submitted to Major Mackenzie for report as to the propriety of the expenditure before payment is made."

On June 13, 1887, the Chief of Engineers made a personal inspection of the work and property pertaining to the Adams flume. On the 9th of July, 1887, I submitted my first report upon the accounts of Mr. Adams, which had been referred to me for examination. After considering some of these accounts, the Chief of Engineers, under date of July 14, 1887, submitted to the Secretary of War that "in view of their extraordinary character, the absence of proper receipts, the want of proper evidence as to the necessity for the expenditure, etc., connected with the crude ideas of Mr. Adams in regard to the disbursement of public money, and his want of the business capacity requisite for conducting the work intrusted to him, and also the doubtful character of the result to be obtained, it would seem proper that the whole subject should be submitted for investigation to a Board of Engineers."

With the approval of the Secretary of War a Board was constituted "to investigate and make report in regard to all matters concerning the work in progress in connection with the practical test of the flume invented by M. J. Adams, provided for by the river and harbor act of August 5, 1886, and also as to the advisability of its continuance." This Board submitted a report under date of August 25, 1887, which fully considers the merits of the invention and the methods of Mr. Adams. The conclusions are given in following extracts from the report:

As to the invention: It is the opinion of the Board that it will not be successful, even upon a small scale, to say nothing of the idea of maintaining a channel of width and depth sufficient for navigation from Saint Paul to the Gulf of Mexico by means of a line of pipe laid in the middle of the river between those points.

* * * * * * *

Eight years have elapsed since the first appropriation was made for the practical test for the Adams flume; more than $28,000 have been expended upon it. Not a foot of the flume has, as yet, been placed in the river for trial, and there does not appear at this writing any probability that the flume, even with the further expenditure of the $15,000 appropriated, will be any nearer readiness for a full test than it now is. The Board, therefore, after full consideration of the facts in the case, is of the opinion that further continuance of this test is not advisable.

By letter of the Chief of Engineers dated October 6, 1887, I was instructed to "take charge of the work pertaining to the Adams flume at as early a day as practicable, together with the public property pertaining thereto, and make such examinations of the condition of the work and property as may be deemed necessary, with a view to reporting the condition and the proper disposition to be made thereof, and also of any accounts that may be due and unpaid."

I immediately notified Mr. Adams of the instructions received and arranged for taking possession of the property at the earliest day practicable. By this arrangement Mr. Adams was given about two weeks in which to close up his work. At the close of the season I removed all portable Government property pertaining to Mr. Adams's work to Boulanger Slough, where other public property is stored under the care of watchmen. The property will remain undisturbed until a final disposition is decided on.

The settlement of the outstanding liabilities connected with this work has been a difficult matter, owing to the failure of Mr. Adams to keep any records or accounts and his inability to furnish any practical assistance. So far as is known all bills have now been settled, excepting a few material items for which Mr. Adams paid cash without taking proper receipts, and the labor accounts of a few men whose whereabouts can not be discovered. But as no statement of liabilities can be obtained it is not known but that other claims will be presented in the future. A few claims have been presented by Mr. Adams on which

payment has been refused, the expenditures being for personal matters having no connection with the test of the flume as authorized by the Secretary of War.

In a communication to Congress Mr. Adams made a statement that he had 4,300 feet of the flume completed "for establishing a permanent channel in the Mississippi River." An inspection and interview in the spring of 1887 developed the fact that instead of 4,300 feet of completed flume he had on hand a lot of sheet iron pipe only intended for experimental purposes, and that not a foot of this experimental pipe was completed or ready for a test. The first proposition made by Mr. Adams upon resuming operations was to abandon some of his former plans and material and purchase new valves and discharge elbows, differing materially from those which for many years he had considered most proper. This change Mr. Adams considered most essential to the successful working of his machine. Though no good reasons were given for the changes desired, permission to make them, for 500 feet of pipe, was granted, to the end that the practical test, if ever reached, might be complete and conclusive even to the mind of Mr. Adams.

The season's operations, which were a repetition of those of former seasons, can be described in a very few words. As a result of Mr. Adams's management the changes were not completed during the year, and at the close of the season the practical test was advanced but little further than at the beginning.

The mechanical construction of such an apparatus as appears necessary for practically testing the ideas advanced in a general way by Mr. Adams is not mysterious or complicated. Any good mechanic could have constructed such a machine in a short space of time and at comparatively small cost. And if Mr. Adams had placed his work in the hands of such a mechanic years ago, in place of trying to work it out for himself, he would have learned long since that no contrivance based on his ideas will be of the slightest value for "establishing a permanent channel in the Mississippi River."

The balance of the discretionary allotment for Mr. Adams remaining on hand is $12,857.47. Excepting what is required for the payment of the few outstanding liabilities, this balance is now available for legitimate work of river improvement.

GENERAL REMARKS.

The stage of water during the past fiscal year has been quite remarkable. During the summer and fall of 1887 the river at all points was very low, and at some places almost reached the low water of 1864. During the spring of 1888 the river was at a flood stage, at many points being higher than in 1880 and 1881, and almost reaching the highest recorded flood of 1851. The river still remains at a high stage.

The works heretofore carried out have continued to exercise a most beneficial effect, and at points where improvements have been carried to completion serious trouble has been done away with, but new difficulties are liable to arise at points where no work has yet been carried out. The results already accomplished show that the Mississippi River between Saint Paul and the Des Moines Rapids can be put in such condition as to make navigation sure and comparatively easy, but to accomplish this requires time and continued work under liberal appropriations.

In January last there was held at Dubuque, Iowa, a convention composed of delegates from the towns and cities of the river between Saint Paul and Saint Louis. Nearly all these delegates were lumbermen,

steam-boat owners, or experienced and practical navigators. These gentlemen are familiar with the condition of the Mississippi River before and since the work of improvement was undertaken by the Government, their knowledge being gained by personal observation and financial results. Among the resolutions of the convention were the following:

4. That all river and harbor works undertaken by the Government should be considered as business enterprises in which the value of the improvement and the amount of money to be expended should be measured by the saving which will result to commerce and the general public. Upon this basis the money heretofore expended upon the improvement of the Upper Mississippi River has already been many times repaid, and largely increased appropriations are justified. The work already carried out by the Government has alone rendered navigation of the Upper Mississippi possible during the past two seasons of extreme low water, and has saved many times its cost in the reduced rates of freight due to river competition. Such saving shows that in the improvement of the upper river the people have a good investment.

The system of improvements now being carried out is, in the judgment of this convention, the proper one, and is accomplishing desired results. Its continuance under liberal appropriations would soon give a safe and permanent channel of sufficient depth to meet the demands of commerce.

As has been heretofore explained, it is desirable, if the radical improvement of the Upper Mississippi is to be continued and carried to a successful completion, that it should be carried on under liberal appropriations. As an amount that can be expended during the fiscal year ending June 30, 1890, I submit an estimate of $1,500,000. It will be remembered that this is an estimate for carrying on work over about 500 miles of river, and, though the estimate is apparently for one work, it covers a large number of works, which, while belonging to one system, are, in fact, independent of each other. In giving an amount that can be expended in one year, it is to be understood that the economical and proper expenditure of such a sum must be preceded by adequate preparation. Such preparation requires time, and can not be made till the means for carrying on the work are in sight.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "Improving Upper Mississippi River." These statistics do not in any sense indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi in any improved condition has upon freight rates must be taken as a measure of its importance.

The existing project for this work is one of general methods and plans, rather than details. No definite estimate of cost of completion can well be given. Projects for the expenditure of each appropriation, in accordance with approved plan and methods, are presented in lieu of a general project for completion of work.

Summary of expenditures for calendar year ending December 31, 1887.

Saint Paul to Hastings	$45,328.96
Read's Landing to Minneiska	6,012.38
Minneiska to Winona	13,095.99
Homer to Queen's Bluff	24,885.21
Coon Slough	118.59
Crooked Slough	10,705.66
Guttenberg to Waupeton	29,643.68
Sand Prairie to Savanna	31,740.97
Rock excavation, etc., on Rock Island Rapids	13,196.72
Buoys on Rock Island Rapids	498.78
Andalusia	3,662.57
Otter Island to Nauvoo	28,814.60
Snag-boat *General Barnard*	4,935.62
Dredge *Phœnix*, cutting new channels	2,433.48

Surveys and gauges	$2,058.25
Purchase, care, and repair of plant	12,937.16
Total (general improvement)	230,068.62
Harbor at Lake City (allotted by act of July 5, 1884)	10,954.52
Practical test of Adams flume (allotted by act of August 5, 1886)	1,708.68
Total expended	242,731.82
Less receipts from sale of fuel	91.91
Net expenditure	242,639.91

General statement of receipts and expenditures.

Expended by vouchers from commencement of improvement to June 30, 1888:		
For general improvement		$1,498,420.20
For harbor at Lake City		11,985.23
For practical test of Adams flume*		22,142.53
For office of Chief of Engineers		1,354.50
		1,533,902.46
Deduct amount received from sales of fuel	832.64	
Deduct amount received from sale of rock	1,078.05	
		1,910.69
Net cost of improvement		1,531,991.77
Balance July 1, 1888		65,508.23
Total appropriated		1,597,500.00

Abstract of appropriations.

By act approved—	
June 18, 1878	$250,000
March 3, 1879	100,000
June 14, 1880	150,000
March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved—	
July 5, 1884 (general improvement)	250,000
July 5, 1884 (applied to harbor at Lake City)	15,000
August 5, 1886	382,500
Total	1,597,500

Net expenditures on the various sections of the river between Saint Paul and Des Moines Rapids from commencement of improvement to July 1, 1888.

Locality.	Distance.	Amount.
	Miles.	
Saint Paul to Hastings	27	$355,031.06
Hastings to head of Lake Pepin	32	47,189.05
Harbor at Lake City		11,985.23
Foot of Lake Pepin to Alma	12	187,342.30
Alma to Winona Bridge	29	218,160.55
Winona Bridge to La Crosse Bridge	31	68,861.62
La Cross Bridge to McGregor Bridge	72	78,441.19
McGregor Bridge to Dubuque Bridge	59	81,231.19
Dubuque Bridge to Clinton Bridge	67	49,752.36
Clinton Bridge to Rock Island Bridge	40	25,663.56
Rock Island Bridge to Keithsburgh Bridge	58	36,438.49
Keithsburgh Bridge to Des Moines Rapids	60	175,511.92
Surveys, gauges, and meter-work		74,518.55
Snag and dredge boats and wrecking		26,552.44
Facilitating navigation through bridges		1,201.12
Plant at estimated value		71,955.61
Practical test of Adams flume		22,142.53
Total		1,531,991.77

* In addition to this amount, there were expended by Mr. Adams in connection with practical test of flume $8,000 appropriated by act of August 2, 1882, as a separate item.

Financial statements.

1. *General improvement.*

July 1, 1887, amount available		$240,662.64
Received from sale of fuel		105.04
Received from allotment for practical test of Adams flume		12,790.42
		253,558.10
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$191,131.69	
July 1, 1888, outstanding liabilities	215.65	
		191,347.34
July 1, 1888, balance available		62,210.76

2. *Allotment for practical test of Adams flume.*

July 1, 1887, amount available *		$14,611.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,754.29	
July 1, 1888, outstanding liabilities	67.05	
Amount transferred to account of general improvement	12,790.42	
		14,611.76

3. *Applied to Lake City, Minn.*

July 1, 1887, amount available	$15,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11,985.23
July 1, 1888, balance available	3,014.77

Money statement.

July 1, 1887, amount available		†$270,274.40
Received from sale of fuel		105.04
		270,379.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$204,871.21	
July 1, 1888, outstanding liabilities	282.70	
		205,153.91
July 1, 1888, balance available		65,225.53
Amount appropriated by act of August 11, 1888		600,000.00
Amount available for fiscal year ending June 30, 1889		665,225.53
Amount that can be profitably expended in fiscal year ending June 30, 1890. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,500,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1888.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from

* This amount was, in my money statement for previous year, given as $15,000, and included in "balance available July 1, 1887," there being at that date no record in this office of an expenditure of $388.24, made in Washington on account of test of Adams flume.

† This amount differs from the balance reported in money statement of previous year. It includes $15,000, appropriated for Lake City, which amount at date of previous report was included under special head of "Barbors of refuge on Lake Pepin, Lake City, Minn.," and it excludes $388.24, expended in Washington, from allotment of $15,000 for the practical *test of Adams flume previous* to June 30, 1887, of which expenditure *there was no record in this office at* the date of previous report.

Saint Paul, Minn., to vicinity of Burlington, Iowa, for the calendar year ending December 31, 1887:

SAINT PAUL TO HASTINGS.

Operations were carried on during the season by hired labor and the use of United States tow-boat *Fury* and steam-launch *Bessie* and portions of plants 1 and 2.

Details of this important work are given in the following extracts from the report of Mr. J. D. DuShane, superintendent in local charge:

* * * * * * *

"At the time of resuming operations, June 6, 1887, the crossing at Red Rock gave the most trouble to boats, and work was first undertaken at this point. Pile-dam 18 (sheet 2),* built in 1884, was lengthened 200 feet, and made a solid brush and rock dam over its entire length. Solid brush and rock dams 24, 25, 26, 28 (sheet 2); 20 (sheet 3), and Pile-dam 27 (sheet 2) were built in this vicinity. Dam 1 (sheet 3), was lengthened 200 feet and raised over its entire length; this dam was built in 1878. The shore protection on right bank opposite Island No. 3 was repaired over most of its length by adding rock to the lower part of the bank where the first covering of rock had been partly rubbed off. Work was finished here July 8.

"Dams 18, 24, 25, and 28 (sheet 2) were built to confine the flow of water to narrower limits on the bar, and thus induce the cutting away of the same, while Dams 26, 27 (sheet 2), and 20 (sheet 3) were put in with the double purpose of narrowing the channel and of catching and retaining the sand set in motion from the bar above.

"On July 9 the plant was towed to Pig's Eye. At this point, Dam 2 (sheet 1), built in 1882, was extended 150 feet and raised over its whole length. Solid brush and rock dams 7, 8, 10, and Pile-dams 6 and 9 (sheet 1) were constructed. Slight repairs were made to the shore protection opposite Dam 10 (sheet 1).

Dams 2 and 7 (sheet 1) were built for the purpose of warding boats off the rocks in the bed of the river as well as for confining the flow of water at low stages to narrower limits. When the channel becomes wider it will be advisable to lengthen these dams about 50 feet in order to completely cover the rocks. In consequence of the construction of Dams 2, 6, and 7 (sheet 1) a large movement of sand and gravel took place on the bar, and a rapid deepening occurred over its entire length. Much of this sand and gravel found a permanent lodging place below Dams 6, 8, and 9 (sheet 1), these three dams being built with this object in view, as well as for narrowing the channel. Dam 10 (sheet 1) was built across a bar to hold it in its present position.

"Work at Pig's Eye was closed on August 2, and the plant was moved to Merrimac, where the crossing from the day-beacon to Island No. 7 had recently become bad. This event was not wholly unexpected, for during the past two years much sawdust was deposited below the bar, gradually filling up the approach to the crossing and making it more and more difficult for ascending boats to mount the reef. This shoaling forced the necessity of making a radical change in the position of the channel, compelling the closing of the existing channel and the opening of a new one through the bar at the foot of Island No. 7. This is a most desirable correction, but, owing to the extreme low stage of water and very slack current, it was attended with some difficulties and delays that are not ordinarily encountered in making these changes. However, in six days after the old channel was closed to navigation an opening in the bar was accomplished, which, though not as wide and deep as desired, was sufficient to permit the passage of boats during the remainder of the season. There is a large body of sand, sawdust, and other mill refuse, such as bark, edgings, pieces of slabs, etc., composing this bar, which must be moved by the current, and perhaps a year or two may elapse before the improvement can be considered as completed, but it is expected that from the opening of navigation in 1888 no further trouble will be encountered here.

"Work was begun at Island No. 7 on August 3 and continued until September 26. During this time Dam 14 (sheet 3) was lengthened 200 feet, solid brush and rock dams 21, 22, 23, 24, and 25 (sheet 3) were built, and the bank of Island No. 7 was protected from near the head to the old protection at the foot, a distance of 2,800 feet. The tow-boat *Fury* was engaged three days working her wheel on the bar, in order to stir up and help carry away the sand, sawdust, slabs, etc., of which this bar is composed; by this means much assistance was rendered in cutting a passage through the bar.

"The extension of Dam 14 (sheet 3) and the construction of Dams 21 and 22 (sheet 3) were for the purpose of forcing the channel through the bar; Dams 23, 24, and 25 (sheet 3) were built to confine the channel to the right bank along Island No. 7 and to hold in place the large bar between Dams 23 and 24.

"On September 15 a part of the force were put at work lengthening and repairing dams below Merrimac.

*Sheet numbers are those of the general maps, survey of 1878-1879.

"On September 27 the plant was taken to the foot of Robinson's Rocks, where work was continued until October 11. Dam 11 (sheet 3) was extended 90 feet; Dam 12 (sheet 3) was lengthened 100 feet and changed to brush and rock dam; Dam 8 (sheet 3) was extended 175 feet; Dam 5 (sheet 4) was extended 100 feet; Dam 9 (sheet 4) was extended 150 feet; Dam 10 (sheet 4) was lengthened 225 feet; pile-dam 12 (sheet 4) was changed to brush and rock dam, and some repairs were made to the shore protection opposite Dam 8 (sheet 3). The new works consist of Dams 13 and 14 (sheet 4) extending from the right bank, below Dam 12, and 1,000 feet of shore protection on right bank, extending up from that built in 1884. By the extension of Dams 9 and 10 (sheet 4) and the construction of Dams 13 and 14 (sheet 4) the water was confined to much narrower limits, and there resulted a marked increase in depth on this crossing.

"From October 3 to 15 a small party was engaged in removing the dangerous rocks at Robinson's Rocks. About 60 rocks of various sizes were found in the bed of the river, most of them near the head of the Rocks, and were removed by blasting. For each rock a charge of dynamite sufficiently large to completely destroy it was used; in every instance the fragments were widely scattered, none being left large enough to be troublesome. All the rocks on shore that were liable to prove dangerous to navigation were broken into riprap by blasting and sledging. This work extended from the head to the foot of the Rocks, a distance of about 4,500 feet.

"On October 12 the plant was moved to Island No. 16, where work was begun on dams and shore protection. In this stretch of river, about 2 miles in length, the channel was tortuous and difficult of navigation, and has been growing worse during the past two years. In this vicinity, 12 solid brush and rock dams, numbering from 16 to 27, inclusive (sheet 5), were built; 16 to 22, inclusive, were built from the right bank, 23 to 27, inclusive, were built from the left bank. The shore protection at the foot of Gray Cloud Island, built in 1886, was extended 500 feet at the upper end and 200 feet at the lower end. Owing to the low stage of water and the crookedness of the channel, it was impracticable, during the progress of the work, to construct all the dams necessary to complete this system, except at the expense of closing the river to navigation. However, it is expected that the dams put in will be sufficient to force a channel through the bars at Island 17 and at the mouth of Boulanger Slough before another low water occurs, in which event the system can be completed. This work was closed November 4.

"On October 17 the crew engaged in removing rocks was transferred from Robinson's Rocks and put at work breaking up the rocks between the mouth of Boulanger Slough and Nininger Landing, a distance of 2,500 feet. This work was suspended November 5. More than 200 rocks were removed from the river-bed by blasting. That portion of the river-bed and shore below the quarry at the mouth of the slough was cleared of all rocks that were considered dangerous to navigation; but in front of the quarry only those that proved troublesome at this time were removed. It will be necessary to continue this work at the latter place at some future time.

"Operations were suspended for the season and the plant was laid up for the winter in Boulanger Slough on November 5.

"The work accomplished during the season consists of 30 new dams, 8 extensions to dams, 3 new shore protections, 2 stretches of shore and river-bed cleared of rocks, 4 dams raised, and 3 shore protections repaired. The new dams and extensions form a length of nearly 2¼ miles; the shore protections a length of almost seven-eighths of a mile. Expressed in feet, the total lengths are as follows: 30 new dams, 10,495 feet; 8 extensions to dams, 1,300 feet; 3 new shore protections, 4,500 feet; shore and adjacent river-bed cleared of rocks, 7,000 feet; 4 dams raised, 1,600 feet; 3 shore protections repaired, 2,000 feet.

* * * * * * *

"It is desirable that works for protecting the banks and for contracting the width of the low-water channel be put in at the following places during the season of 1888, if funds and time permit; all these works form part of the general system projected for the permanent completion of the stretch of river under consideration: Shore protection on left bank at Frenchman's Bar; dams from the right bank in the vicinity of Frenchman's; shore protection on the right bank at Pig's Eye; dams from the left bank above Pig's Eye Slough; dams from right bank at Kaposia, or the dams from opposite shore lengthened; dam from Island No. 2, near head; dam from right bank below Dam 28 (sheet 2); dam from left bank below Dam 12 (sheet 3); dams from left bank below Pine Bend, and the opposite shore protected; dams and shore protection in the vicinity of Island 14; dam from right bank between the tow-head and Island 15; dam below Dam 18 (sheet 5); dam below Dam 19 (sheet 5); dams below Dam 25 (sheet 5); shore protection on left bank at head of Island No. 18; dams between Nininger Slough and Hastings; shore protection below Hastings should be extended; and, in addition to the works mentioned, such dams and shore protections as can be best determined by the conditions of the river or by the requirements of navigation during the season of active operations.

"Repairs should be made to the following works: Dams in the vicinity of Kaposia; dams opposite Newport; Dam 11 (sheet 4); shore protection below Dam 9 (sheet 3); dams in the vicinity of Island 15; shore protection opposite Nininger.

* * * * * * *

"The materials were purchased in open market, the prices ranging, according to places of delivery, as follows: Rock on barge, 52½–60 cents per cubic yard; brush on barges, 31½–33½ cents per cubic yard; poles on barge, 3–3½ cents each.

"About 90 per cent. of all material was towed up-stream on the very low stage of water which existed throughout the year, the length of tow varying from 2 to 35 miles.

* * * * * * *

List of works constructed and repaired and of materials used during season of 1887, *between Saint Paul and Hastings.*

Works.	Dimensions.		Materials.	
	Length.	Height above low water of 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cu. yds.*	*Cu. yds.*
Sheet 1:				
Dam No. 2, repairs and extension	150	4.0	429.1	1,259.5
Dam No. 6	800	3.5	507.7	1,123.4
Dam No. 7	450	4.0	499.5	716.0
Dam No. 8	325	3.5	410.5	1,182.8
Dam No 9	275	3.5	273.8	598.8
Dam No. 10	225	4.0	178.9	545.9
Shore protection opposite Island No. 1, repairs	.....	.....	46.2	.....
Sheet 2:				
Dam No. 17, repairs	.....	4.0	145.5	.....
Dam No. 18, repairs and extension	200	4.0	912.3	1,920.6
Dam No. 24	570	3.5	649.2	1,465.9
Dam No. 25	600	3.0	602.2	1,314.4
Dam No. 26	350	3.5	329.0	461.0
Dam No. 27	260	4.0	141.3	956.7
Dam No. 28	260	4.0	243.8	856.4
Shore protection opposite Island No. 3, repairs	.....	.....	314.9	.....
Sheet 3:				
Dam No. 1, repairs and extension	200	4.0	421.4	915.2
Dam No. 8, extension	175	4.0	185.9	400.0
Dam No. 11, extension	90	3.5	143.3	204.0
Dam No. 12, repairs and extension	100	3.5	224.4	219.0
Dam No. 14, extension	200	3.5	710.5	2,221.7
Dam No. 20	250	3.5	227.9	294.0
Dam No. 21	475	4.0	681.9	1,406.3
Dam No. 22	400	3.5	627.2	1,185.6
Dam No. 23	450	3.5	506.8	1,200.0
Dam No. 24	385	4.0	363.2	585.3
Dam No. 25	200	4.0	278.6	829.1
Shore protection on Island No. 7	2,800	.....	2,578.7	2,668.3
Shore protection opposite Dam No. 8, repairs	.....	.....	134.6	.....
Sheet 4:				
Dam No. 5. extension	100	2.0	220.0	741.0
Dam No. 9, extension	150	4.0	233.6	729.4
Dam No. 10, extension	225	3.5	160.1	414.5
Dam No. 12, repairs	375	4.9	138.8	297.7
Dam No. 13	375	4.0	372.5	500.0
Dam No. 14	190	4.0	204.3	586.5
Shore protection below Dam No. 14	1,000	.....	942.1	712.0
Sheet 5:				
Dam No. 16	265	4.0	303.2	803.4
Dam No. 17	250	4.0	175.5	548.2
Dam No. 18	275	4.0	263.9	620.4
Dam No. 19	325	4.0	319.9	895.1
Dam No. 20	200	3.0	87.4	200.0
Dam No. 21	200	3.0	89.0	200.0
Dam No. 22	200	3.0	143.5	237.7
Dam No. 23	150	4.0	289.5	545.3
Dam No. 24	425	4.0	372.5	829.0
Dam No. 25	300	4.0	239.7	748.6
Dam No. 26	200	4.0	185.8	296.0
Dam No. 27	200	4.0	335.3	695.9
Shore protection, Gray Cloud Island, extension	700	.....	622.0	599.1
Shore protection opposite Nininger, repairs	.....	.....	142.0	.....
Total	.....	.....	18,635.9	35,000.7

Number of poles put in above works, 22,584.

Financial statement for works of improving Mississippi River between Saint Paul and Hastings during the season of 1887.

Amount expended in the field for the calendar year 1887 (from distribution sheets)	$43,395.27
Cost of removing rocks from channel	508.18
	42,887.09
Proportion of general superintendence and office expenses	1,933.69
For use of plant	7,589.25
Total cost of works	52,410.03
Cubic yards of material put in works:	
Brush and poles	35,750.7
Rock	18,635.9
Total	54,386.6
Cost per cubic yard in place	$0.963
Cost per cubic yard in place, exclusive of superintendence, office, and plant charge	.788

"In considering the cost of this season's work it is important to take into account the unusual conditions encountered in carrying it on, namely, the long tow on shoal water; the large amount of material put in dams requiring a double handling, and, in many cases, a wheeling of rock and carrying of brush a distance of 200 feet or more, and the comparatively small proportion of shore protection to dam work. All these conditions tend to greatly increase the cost of material put in place. On the other hand, the excess of brush used tends to reduce the average cost per cubic yard in place."

* * * * * * *

ANDALUSIA.

An allotment was made in 1887 for repairing the dam at Andalusia and building a small dam, closing the cut-off at Vela Chute. This work was accomplished in April, 1887, by hired labor and purchase of rock in open market, the steam-launch *Louise* and a fleet of six barges being used for moving the material.

Financial statement.

Amount expended in the field (from distribution sheets)	$3,506.37
Quota of general superintendence and office expenses	156.20
For use of plant	613.21
Total cost of work	4,275.78
Cubic yards of rock put in the work	3,411.2
Cost per cubic yard in place	$1.25
Cost per cubic yard in place, exclusive of superintendence, office, and plant charge	1.03

COON SLOUGH.

On the 18th and 19th of May, 1887, the small island at the foot of Coon Slough, long a bad obstruction to rafts, was removed by United States dredge *Phœnix*. The material was disposed of by casting in the deep water surrounding the island.

The cost of this work, including plant charge, was	$138.44
Number of cubic yards of material removed	2,037.0
Average cost per cubic yard	$0.068

CROOKED SLOUGH.

An allotment of $20,000 was made in 1887 for this locality, in continuance of the project of 1886, the work contemplated comprising about 2,000 lineal feet of shore protection in the slough, the closing of several cut-offs, the raising and strengthening of the Harbor Slough Dam, and repair of existing works.

Work in the field was carried on from May 26 to June 10, and from October 14 to 30, and was in my personal charge. The steam launches *Louise* and *Stella* performed the towing, the remainder of the fleet consisting of building-boat, quarter-boat, grasshopper, and fifteen barges, all belonging to the United States. The work accomplished is as follows: The construction of Dam 6, which closes a small slough near the head of Crooked Slough, which dam, with continuous shore protection, is 400 feet long; the extension of shore protection at head of Crooked Slough 265 feet; the extension of shore protection opposite Dam 2, 510 feet; the extension of shore protection above and below Dam 2, 1,810 feet; the raising of Dam 5 and repair and extension of shore protection above and below; shore protection on Island 156, at foot of Crooked Slough, 850 feet; repairs to shore protections at various points in the slough, and the raising and strengthening of the closing-dam in Harper Slough. The shore protection of the right bank near foot of Crooked Slough, built in 1886, was found to be in a very bad condition and considerable material was used in repairing and strengthening it. The bank is very low and soft, marshy in fact, in a sharp bend with very deep water and strong current in contact. The less elevated portion of it was raised about 2 feet by a mattress loaded with rock, and the same means were used in the construction of the new protection at the foot of the slough, where the conditions were similar, excepting that the water near the bank was not so deep. The other shore protections and the dams in the slough were but slightly damaged and were very easily and cheaply repaired; but it is believed that the protections near the foot of the slough, both the new and the old, where the bank is low and marshy, will need further work another season.

The dam in Harper Slough was uninjured and had settled but slightly; but it was thought proper to raise and strengthen it, and the remainder of the rock on hand was used in so doing. It should receive another course of brush and rock, so as to raise it about 2 feet additional.

The channel in Crooked Slough, although much straightened and giving no trouble during the season, was not increased as much in depth as was expected; but it is believed that another season will show still further improvement in depth and width. Ordinarily, in cases where, as in this instance, there are large sand-bars to be moved, several years elapse before the full beneficial results are obtained. The river above the slough for several miles is greatly improved and it is not believed that the construction of closing-dams at Capoli and Ferryville sloughs will be found necessary.

List of works constructed and repaired, and of materials used during season of 1887, *in vicinity of Crooked Slough.*

Designation.	Length.		Material.	
	Dam.	Shore protection.	Rock.	Brush.
Sheet 28:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam No. 6 and shore protection, cut off left bank	400	.....	283.5	261.0
Shore protection at head of Crooked Slough, left bank, extension	.....	265	331.3	399.3
Shore protection opposite Dam No. 2, extension	.....	510	781.8	414.4
Shore protection above Dam No. 2, extension	.....	1,810	2,941.9	838.7
Dam No. 5 raised and repaired; shore protection repaired and extended	.....	100	1,603.6	246.1
Shore protection on Island 156, foot of Crooked Slough	.....	850	1,067.9	794.6
Dam No. 1, Harper Slough, raised	.....	.....	897.1	.....
Total	400	3,535	7,907.1	2,954.1

The aggregate length of dams and shore protections now constructed in the vicinity of Crooked Slough is: dams, 1,686 feet; shore protections, 12,615 feet.

Financial statement for works in the vicinity of Crooked Slough, during the season of 1887.

Amount expended in the field during the calendar year 1887, (from distribution sheets)	$10,248.97
Quota of general superintendence and office expenses	456.69
For use of plant	1,792.40
Value of material purchased in 1886 and used in work	621.26
	13,119.32
Value of material on hand at close of work	64.40
Total cost of work	13,054.92
Material put in:	
Rock ... cubic yards	7,907.1
Brush ... do	2,954.1
Total ... do	10,861.2
Average cost per cubic yard of material in place	$1.20
Average cost per cubic yard in place, exclusive of office expenses and plant charge	0.995

The nature of the work requiring a great excess of rock, the more expensive material, largely increased the average cost per cubic yard of material in place.

MINNEISKA TO WINONA.

An allotment of $15,000 was made for this locality for 1887, the work contemplated consisting in the repair and extension of existing works and the construction of two wing-dams near Winona.

In January and April some repairs were made to the dam across Rollingstone Slough. The west end was cut down about 2 feet and the east end was raised; 719.6 cubic yards of rock were put in the work by Jacob Richtman, of Fountain City, at an agreed price of $1 per cubic yard. The total cost of the above work was $942.47.

Operations with steam-launches *Louise* and *Stella* and the fleet of barges used earlier in the season at Crooked Slough were commenced July 22 and continued until August 10; were resumed September 10, carried on until September 27, and again continued October 6, 7, and 8. The work was in my personal charge. Rock was obtained from Albert Kirchner and S. D. Van Gorder, under formal contract, at 75 cents per cubic yard on United States barges, and also from G. W. Allen, by open market purchase, at 70 cents per cubic yard on United States barges. Brush was obtained in open market at 28 cents per cubic yard loaded.

The work performed was as follows:

The raising and strengthening of Dam 6 (sheet 16), closing the chute of Island 53. The middle ground bar at this point had so crowded down upon the Island as to make the eastern passage by rafts difficult and dangerous, owing to the strong draught down the chute of Island 53 when the water was running over the dam. The channel on the western side was too shallow for use at low stages, and even when the river was up to a stage of 7 feet rafts were obliged to split in order to make the passage safely; thus great delay was caused. The dam being raised, the draught down the chute was checked and the eastern channel became much easier to run. In connection with this work the shore protection at the head of Island 53 was put in good repair. Considerable repairs were made to Dam 7 (sheet 16), closing the chute of Island 55, and to adjacent shore protection. Slight repair swere made to Dams 1, 6, 19, and 24 (sheet 17), and shore protection at the head of Island 58. The shore protection below Dam 9 (sheet 17) was also repaired and extended 600 feet. All the above work was performed in July and August.

The work of September consisted in the construction of Wing-dam 22 (sheet 18), 280 feet in length, running out from Island 71, nearly opposite Dam 18 (sheet 18), with its crest at an elevation of 4 feet above low water of 1864; shore protection 1,150 feet in length on Island 67; shore protection 800 feet in length opposite Dam 15 (sheet 18); and shore protection 500 feet long on Island 62, near the head of Betsy Slough. Slight repairs were made to Dams 7, 23 (sheet 17), and Dam 20 (sheet 18).

In October 150 linear feet of shore protection was built on Island 62, and some repairs were made to shore protection opposite Fountain City.

Nearly all the old work in this section *of the river is* now in excellent repair.

List of works constructed and repaired and of materials used during season of 1887 *from Minneiska to Winona.*

Designation.	Length.		Material.	
	Dam.	Shore protection.	Rock.	Brush.
Sheet 16:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 6, raising			1,411.6	745.3
Dam 7 and shore protection, repairs			1,490.2	843.2
Shore protection head of Island 53, repairs			372.6	60.0
Sheet 17:				
Dam 1, repairs			385.7	
Dam 19, repairs			50.8	
Dam 24, repairs			148.6	
Dam 7, repairs			55.6	
Dam 23, repairs			54.7	
Shore protection below Dam 9, extension		600	1,118.2	769.0
Shore protection head of Island 58, repairs			178.2	
Shore protection on Island 67		1,100	1,179.5	806.0
Shore protection on Island 62		650	655.4	393.3
Shore protection opposite Fountain City, repairs			59.1	
Sheet 18:				
Dam 6, repairs			106.9	
Dam 20, repairs			265.8	
Dam 22	280		693.2	244.4
Shore protection opposite Dam 15		800	844.8	623.2
Total	280	3,150	9,060.9	4,484.4

Financial statement for works between Minneiska and Winona during the season of 1887.

Amount expended in the field during the calendar year 1887 (from distribution sheets)	$12,537.34
Quota of general superintendence and office expenses	558.65
For use of plant	2,192.61
Total cost of work	15,288,60
Cost of repairs to Rollingstone Dam	942.47
Cost of work by days' labor	14,346.13
Material put in:	
Rock ... cubic yards	9,060.9
Brush ... do	4,484.4
Total ... do	13,545.3
Average cost per cubic yard of material in place	$1.06

In the above work, chiefly repairs, a large excess of rock was used and the price paid for rock, which was bought under formal contract, was high; but the cost of the field-work, exclusive of office expenses and plant charge, was brought down to an average of 85.6 cents per cubic yard.

READ'S LANDING TO MINNEISKA.

For work in 1887 in this locality, a stretch of 25 miles, an allotment of $20,000 was made, it being proposed to repair and strengthen existing dams and shore protections, and to construct some new work near Pine Island. The greater part of the allotment was unexpended.

Operations commenced September 27 and closed October 12, the fleet being then taken to Crooked Slough. Work was performed by hired labor and use of Government plant, the brush and a portion of the rock being towed from Fountain City by the steamer *Barnard*, and the remainder of the rock from Alma by the launches *Louise* and *Stella*. The long tow, at very low water, and the high price of the rock brought from Fountain City made the work very expensive. The Fountain City rock was bought under a formal contract, which had to be carried out. The Alma rock was bought at a cheaper rate in open market.

The work consisted in the construction of Dam 6 (sheet 15), 100 feet in length, with its crest 5 feet above low water, closing a cut-off near head of Pomme de Terre Slough, eastern side in connection with which dam 230 feet of shore protection were built; in the construction of Dam 7 (sheet 15), closing the first cut-off above Pine Island, 100 feet in length, with shore protection in continuation of dam 270 feet long; in the repairing and strengthening of Dams 3 and 4 (sheet 15), closing cut-offs into West Newton Chute; and in the building of 900 lenear feet of shore protection in Pine Island Bend, below Dam 4 (sheet 15).

Repairs to works above Alma had to be postponed to some future time, the plant being more needed at other points until close of season.

List of works constructed and repaired and of materials used during season of 1887 *from Read's Landing to Minneiska.*

Designation.	Length.		Material.	
	Dam.	Shore protection.	Rock.	Brush.
Sheet 15:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 6 and shore protection	100	230	885.3	377.3
Dam 7 and shore protection	100	270	623.0	.....
Dam 4, repairs	.....	.....	39.0	.....
Dam 3, repairs	.....	.....	163.6	.....
Shore protection in Pine Island Bend	.....	900	1,610.7	266.7
Total	200	1,400	3,321.6	644.0

Financial statement for works between Read's Landing and Minneiska during the season of 1887.

Amount expended in the field during the calendar year 1887 (from distribution sheets)	$5,755.90
Quota of general superintendence and office expenses	256.48
For use of plant	1,006.63
Total cost of work	7,019.01
Material put in:	
Rock ..... cubic yards	3,321.6
Brush ..... do	644.0
Total ..... do	3,965.6
Average cost per cubic yard of material in place	$1.77

In addition to reasons above given the great excess of rock made the work expensive. The average cost of the field-work, exclusive of office expenses and plant charge, was $1.45 per cubic yard.

HOMER TO QUEEN'S BLUFF.

An allotment of $25,000 for 1887 was made for this stretch of river, 14 miles in length, and a contract for work was let to Jacob Richtman, of Fountain City, Wis., at $1.53 per cubic yard for rock in place and 72 cents per cubic yard for brush in place. Operations commenced May 30 and continued until September 3.

The work accomplished was as follows:

(1) Repairs to Dam 2 (sheet 19). This dam, built in 1883, and closing the chute of Island 78, was raised to an elevation of 4 feet above low water of 1864, and the shore protections at each end were strengthened.

(2) Construction of Dam 4 (sheet 19), from Island 81 to Minnesota shore, closing La Moille Chute. This dam is 960 feet long, with crest about 4 feet above low water of 1864, and with shore protections 110 feet in length at each end.

(3) Repair and extension of shore protection on head of Island 81. The old shore protection, 1883, received some slight repairs and was extended 1,295 linear feet, 400 feet of which was at the upper end and the remainder at the lower end, of an average width of 28 feet.

(4) Construction of Dam 5 (sheet 19), from Island 81 to Island 82. This dam is 710 feet long, built mostly on sand-bars up to a height of about 5 feet above low water of 1864.

(5) Construction of Dam 6 (sheet 19), closing the chute of Island 87. This dam is 420 feet long, with 235 feet of shore protection at the ends.

(6) Construction of shore protection on Island 87, at its head and on west side, 876 feet in length, and of an average width of 35 feet.

(7) Construction of Wing-dam 7 (sheet 19), running out from Wisconsin shore about half a mile above Island 87, length 1,300 feet. The water was quite shallow along its entire length, which is built to a height of about 4½ feet above low water of 1864.

(8) Construction of shore protection on west side of Island 79, 975 feet in length and of an average width of 30 feet.

The work was under the local inspection of Mr. G. A. Marr.

List of works constructed and repaired and of materials used during season of 1887 *from Homer to Queen's Bluff, under contract with Jacob Richtman.*

Designation.	Length.		Material.	
	Dam.	Shore protection.	Rock.	Brush.
Sheet 19:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 2, repairs	.....	.....	315.4	.....
Dam 4, La Moille Chute	960	229	3,535.1	1,670.7
Dam 5	710	.....	554.4	453.7
Dam 6	420	235	1,636.6	1,080.9
Dam 7	1,300	100	2,527.0	2,026.5
Shore protection on Island 81, repairs and extension	.....	1,295	1,109.7	598.6
Shore protection on Island 87	.....	876	805.8	795.7
Shore protection on Island 79	.....	975	1,017.8	652.6
Total	3,390	3,701	11,501.8	7,278.7

Financial statement for works between Homer and Queen's Bluff, performed by contract during the season of 1887.

Amount paid contractor		$22,838.41
Cost of local inspection, advertising, etc		985.25
Quota of general superintendence and office expenses		1,061.55
Total cost of work		24,885.21
Material put in:		
Rock	cubic yards	11,501.8
Brush	do	7,278.7
Total	do	18,780.5
Average cost per cubic yard of material in place		$1.325

GUTTENBERG TO WAUPETON.

An allotment of $20,000 was made for work in this locality, embracing 16 miles of river. It was proposed to raise the closing-dam in the chute of Island 192, to close Bunker and Jacko Chutes, and protect the shore in the bend opposite Island 198. Contract was let to Sid. J. Truax, of Hastings, Minn., at $1 per cubic yard for rock in place, and $1 per cubic yard for brush in place. After expenditure of the amount ($18,000) called for by his contract, an agreement under a further allotment was made with him to construct some additional necessary shore protection, at 95 cents per cubic yard for rock in place and 70 cents per cubic yard for brush in place.

Work was begun July 1 and completed November 16. Mr. J. F. Marr was the local inspector.

The following works were built, viz:

(1) Bunker Chute closing-dam (No. 1, sheet 34). The western bank at end of dam is protected for a length of 350 feet, and the eastern or island bank 300 feet. The dam is 650 feet long and built to a height of 5 feet above low water of 1864, 200 feet of its length being from 18 to 22 feet high, and the dam gradually growing less in height toward each shore, except about 50 feet in length near the island end, which is from *8 to 12 feet* high.

(2) Jacko Slough closing-dam (No. 4, sheet 33). This dam is 475 feet long, built to a height of 5 feet above low water of 1864, and with shore protections at each end 300 feet long. The shore protection at the east end is from 80 to 90 feet in width.

(3) Shore protection in bend opposite Island 198, 5,030 feet long. A continuous mat was laid and well loaded with rock, the bank above water being graded to a gentle slope and covered with rock alone.

In addition to the above work, some repairs were made to shore protection on east side of Island 190 and at foot of Island 189, and the dam in the chute of Island 192 was repaired and raised about 2½ feet, it now being about 5 feet above low water of 1864.

List of works constructed and repaired and of materials used during season of 1887, *from Guttenberg to Waupeton, under contract and agreement with Sid. J. Truax.*

Designation.	Length.		Materials.	
	Dam.	Shore protection.	Rock.	Brush.
	Feet.	*Feet.*	*Cubic yards.*	*Cubic yards.*
Sheet 33:				
Dam 4 (Jacko Slough)	475	600	3,382.6	1,832.0
Dam 1, repaired and raised	.....	.....	802.3	.....
Shore protection on Island 190, repairs	.....	.....	326.9	.....
Shore protection on Island 189, repairs	.....	.....	364.1	.....
Sheet 34:				
Dam 1 (Bunker Chute)	650	650	6,112.0	4,240.1
Shore protection opposite Island, 198	.....	5,030	7,168.6	4,742.3
Totals	1,125	6,280	18,156.5	10,814.4

Financial statement for works between Guttenberg and Waupeton, performed by contract and agreement during season of 1887.

Amount paid contractor		$27,445.10
Cost of local inspection, advertising, etc		934.03
Cost of general superintendence and office expenses		1,264.55
Total cost of work		29,643.68
Material put in:		
Rock	cubic yards	18,156.5
Brush	do	10,814.4
Total	do	28,970.9
Average cost per cubic yard in place		$1.023

SAND PRAIRIE TO SAVANNA.

An allotment of $30,000 was made for work in this district, embracing 12 miles of river.

The operations of the season are confined to the improvement of the so-called Keller's Bar, or Santa Fé Crossing, which had been troublesome for some years.

The work was let, under formal contract, to A. J. Whitney, of Rock Island, at $1.30 per cubic yard for rock in place, and 70 cents per cubic yard for brush in place. Operations began July 22, and were completed November 10.

The work accomplished was as follows, viz:

(1) Closing-dam 1 (sheet 41), from Island 262 to the Iowa shore. This dam is 375 feet long and is raised to an elevation of 5 feet above low water of 1864. A heavy shore protection, 325 feet in length, was laid at the island end of the dam, but on the Iowa shore no protection was built, the bank being rocky.

(2) Wing-dam 2 (sheet 41), starting near the head of Island 262 and running out on the bar across an intervening pocket, the depth in which was about 10 feet at low water. It inclines slightly up-stream and is 865 feet long, with a T-head 110 feet in length. Its crest is at an elevation of 5 feet above low water.

(3) Dam 3 (sheet 41), a wing-dam running from Island 262 about 200 feet from its foot, crossing a pocket 400 feet wide and about 18 feet in depth at low water, and extending out on the bar about 250 feet. The length of the dam is 660 feet, with a T-head 110 feet long and shore protection 450 feet. It is raised to an elevation of 5 feet

above low water, but will probably need some additional rock, as, owing to lateness of season, the work was suspended before the dam had been made as strong as desirable.

(4) Shore protection on Island 262. This protection commences on the western shore of the island, about 100 feet from its head, and, running around the head of the island, extends down the eastern shore across a cut-off or small chute in the island, and is 1,475 feet in length. It was found necessary at the cut-off to lay two courses of brush and rock and to extend the shore protection down the chute for a little distance on each side.

Mr. Albert Warren was the local inspector in charge of work.

An examination made at the close of the work showed the dams tight and in good condition. A strong current had developed around the T of Dam 3 (sheet 41), quartering down over the crossing to the Government light. The space between the wing-dams is filling up with sand. In the table which follows all the shore protection, including that at ends of dams, is taken together.

List of works constructed and of materials used during season of 1887, *from Sand Prairie to Savanna, under contract with A. J. Whitney.*

Designation.	Length.	Rock.	Brush.
Sheet 41:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 1	375	1,882.2	1,227.4
Dam 2 (upper wing)	865	4,027.4	2,827.1
Dam 3 (lower wing)	660	6,489.4	4,391.2
Shore protection on Island 262	2,250	4,643.8	2,141.7
Total	.....	17,042.8	10,587.4

Financial statement for works between Sand Prairie and Savanna performed by contrac during season of 1887.

Amount paid contractor		$29,566.82
Add cost of local inspection, advertising, etc		820.15
Add quota of general superintendence and office expenses		1,354.00
Total cost of work		31,740.97
Material put in:		
Rock	cubic yards	17,042.8
Brush	do	10,587.4
Total	do	27,630.2
Average cost per cubic yard of material in place		$1.15

ROCK ISLAND RAPIDS.

Under the general project of March 8, 1887, an allotment of $10,000 was made for removing obstructions at various points on Rock Island Rapids. This amount, with that available from the previous year, gave about $12,000 for the work.

Proposals for performing the work were invited and an agreement was made with A. J. Whitney, of Rock Island, the lowest bidder, for removing rock at $7 per solid cubic yard, and $8 per hour for hire of dredging plant in removing sand, loose rock, bowlders, etc. The prices were the same as those paid in 1886. The measurement of the rock was made by the method of displacement, the specific gravity (2.7) of the material having been ascertained by accurate weighing of numerous samples. Mr. C. H. Beuck was the local inspector.

(*a*) *At Cambpell's Chain.*—Work was begun by the dredge in removing loose rock, bowlders, clay, etc., at head of Campbell's Chain on April 9 on patch 6. On the 12th a chisel-boat began on patch 7, the breaking up of which was finished on the 13th. From this time until the 23d one and sometimes two chisels were at work on patch 8. On the 26th the fleet was laid up on account of high water, and no further work was done during the month of April. The result of the month's work was the widening of the available entrance to the cut at Campbell's about 100 feet and the removal of patch 7, a very bad obstruction.

In May the work of excavation was not resumed until the 16th, the high water still continuing. From that time until the close of the month one chisel worked on patches 8 and 9 near the foot of the chain. Operations were much hindered by acci-

dents to, and consequent breakage of, machinery. None of the broken rock was removed by dredge during May.

In June work was continued at this chain and 211.24 cubic yards of rock were removed by dredge.

In July less progress was made than was expected, owing to the extreme hardness of the rock which caused frequent breakages of chisel points and chisel-boat machinery. The dredge was employed a short time in removing loose rock and sand from the cut at the head of Campbell's Chain. One hundred and sixty-five and five-tenths cubic yards of rock were removed.

In August but little progress was made in chiseling for the same reasons as in July. Forty-six and forty-four hundredth cubic yards of rock were removed.

In September considerable progress was made in the chiseling and breaking of rock and 318.49 cubic yards were removed by dredge.

On October 19 the removal of rock at this chain was finished. It is now believed that no further obstruction to navigation at this locality will be found other than the occasional filling up with sand from above the head of the cut. It is possible, however, that some small points of rock may have escaped the chisel and dredge, but no opportunity has as yet occurred for making a careful and thorough examination.

The total number of solid cubic yards of rock excavated and removed at this chain in 1887 was 891.75; total number of hours' hire of dredging plant removing loose rock, sand, etc., was 177¾.

(*b*) *At Saint Louis and Cabin chains.*—On these two contiguous chains work was begun October 19 and continued until November 15, when the available funds were exhausted. Two chisel-boats were employed on patches 1, 1a, 1b, and 3, and the dredge removed the broken rock to the amount of 452.13 solid cubic yards. The dredge was also employed ten hours in removing loose rock. There still remain a number of bad obstructions to navigation at Cabin and Saint Louis chains.

Financial statement for work on Rock Island Rapids, performed by agreement during season of 1887.

Amount paid contractor	$19,905.66
Cost of local inspection	1,728.09
Quota of general superintendence and office expenses	562.97
Total cost of work	13,196.72
For excavation and removal of rock:	
Amount paid contractor	9,403.66
Cost of local inspection	1,490.09
Proportion of general superintendence and office expenses	485.43
Cost of excavation and removal of rock	11,379.18
Total number of solid cubic yards excavated and removed	1,343.38
Average cost per cubic yard	$0.847

BUOYS ON ROCK ISLAND RAPIDS.

On March 19, 1887, steam-launch *Louise*, with steam drill-boat and a small fleet, began resetting the buoys. Work was completed March 31. There were added to the old system of 26 buoys 3 new ones, numbered 9½, 12½, and 17½. The position of No. 10 was changed. All the range stakes were carefully looked up, reset, and changed, where necessary, and repainted.

The old mooring chains were found at Nos. 1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, and 22, and new bolts and chains were put in at No. 2, 6, 10, 15, 20, 21, 23, 24, 25, 26, 9½, 12½, and 17½.

During the season buoys were frequently carried away by rafts, but were as often reset by Mr. C. H. Beuck. On November 16, 17, and 18 the buoys were taken in and stored. But 6 were then found to be missing. The buoys have proved to be of much value to navigation.

The cost of buoyage for the season of 1887, including proportion of plant charges and superintendence and office expenses, was $582.29.

UNITED STATES DREDGE PHŒNIX.

An allotment of $5,000 was made for 1887 for expenses of dredging in cutting new channels at obstructed points. The dredge *Phœnix*, assisted by tow-boat *J. G. Parke*, was employed on this duty *during the entire month of* June, and succeeded in opening

good steam-boat channels at Red Rock, Merrimac, and Frenchman's bars, and at Island No. 17. The amount of material moved during progress of this work was 24,953 cubic yards. From August 10 to 14 the dredge and tow-boat were employed in cutting a channel through a bar at Beef Slough. The channel was made about 300 feet long and 60 feet wide, and sand to the amount of 3,643 cubic yards was dredged.

Financial statement for work performed by dredge Phœnix during season of 1887.

Amount expended in the field	$2,329.67
Proportion of general superintendence and office expenses	103.81
Plant charge	407.43
Total cost	2,840.91
Cubic yards of sand dredged	28,596
Average cost per cubic yard	$0.10

SNAG-BOAT GENERAL BARNARD.

A small allotment was made from the appropriation for "Improving Mississippi River from Saint Paul to Des Moines Rapids" for urgent work. Operations are given under head of "Improving Upper Mississippi River." Amount expended, $4,935.62.

SURVEYS AND GAUGES.

Mr. H. Bosse, draughtsman, with a small party, made a survey between October 4 and 10 of the river from a point about 1 mile above head of Rollingstone Slough to Fountain City. Numerous soundings were taken and a line of levels run with sufficient bench-marks and water surfaces. This survey has been plotted and a project based upon it for work in 1888 in vicinity of Fountain City. The same party subsequently made a similar survey from Pine Island to foot of West Newton Slough. This survey was completed October 17. A project has also been made for work in the locality above mentioned.

Between October 18 and 31 the party was engaged in a survey from Pig's Eye Island to Pine Bend. This work is now being plotted.

Gauges were kept at Hastings, Red Wing, McGregor, and Winona during the year. Gauge records were also obtained from the Signal Service and the bridge keepers at Saint Paul, Dubuque, Rock Island, Keokuk, Burlington, Quincy, Hannibal, and Louisiana. These records have been plotted.

Some expenses incidental to the Board of Engineers on Dubuque Bridge were incurred.

Amount expended on surveys and gauges, etc., during 1887, $2,058.25.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1888.

MAJOR: I have the honor to present a preliminary report of operations for the improvement of the Mississippi River in the division under my charge, extending from Saint Paul, Minn., to the vicinity of Burlington, Iowa, during the second half of the fiscal year ending June 30, 1888:

REPAIRS OF PLANT.

During March and April, 1888, tow-boat *Fury* and steam-launches *Louise* and *Stella*, which had been docked at Rock Island in the fall of 1887, were thoroughly repaired and partially repainted.

SURVEY OF MOLINE AND DUCK CREEK CHAINS OF THE ROCK ISLAND RAPIDS.

On January 19, 1888, a party in charge of Inspector C. H. Beuck was put in the field to make soundings through the ice. The field work was completed February 22, and from that time until May 1 a small force was engaged in plotting the notes

and making estimates of quantities of rock in the various patches above grade within the channel limits. Base lines were run and the ice field laid out into squares of 20-feet sides at Duck Creek Chain and 10-feet sides at Moline Chain, and soundings were taken at the corners of the squares. At Moline Chain, the rock bottom being more irregular than at Duck Creek, the squares were made smaller. The sounding was performed with a level rod, and the elevation of the bottom of the river at each corner of every square was thus obtained, connection having been made with the permanent bench-marks of the Rock Island Rapids. These bench-marks have been many years in use and frequent observations of water-surface, taken from them at very low water and other stages of the river, have enabled us to adjust very accurately the low-water plane on all the chains, as well as to determine, from the reading of the gauge at Rock Island Bridge, or from a water-surface elevation taken at any of the bench-marks, what the stage of water is at any point on the rapids. A table has been prepared showing the comparative stages at various points on the rapids from low water of 1864 to an 8-foot stage on Rock Island Bridge.

We were fortunate in finding the river entirely closed and the ice solid at the chains surveyed, such being very seldom the case even in the coldest winters.

Maps and tracings have been prepared on a scale of 1 inch to 50 feet at Moline Chain and 1 inch to 100 feet at Duck Creek Chain. These maps and tracings show low water and grade (4 feet below low water of 1864) contour lines and elevations, the various patches of rock lying above grade, and give tables of estimates of quantities of rock above grade, and also the channel limits.

Number of soundings at Moline Chain (over an area of about 610,000 square feet 5,598

Number of soundings at Duck Creek Chain (over an area of about 525,000 square feet) 2,765

BUOYS ON ROCK ISLAND RAPIDS.

April 7, 1888, the tow-boat *Fury*, assisted by steam-launch *Stella* and drill-boat, began replacing the buoys on Rock Island Rapids. The work was much delayed by bad weather and the high stage of water prevailing, but was completed April 14. Three new buoys were established this spring, the total number of buoys placed being 32. All the range stakes were carefully examined, and were reset and changed where necessary.

SURVEY FROM FAIRPORT TO MUSCATINE.

On April 16, 1888, the survey party, in charge of Inspector J. C. McElherne, was taken to Fairport by the tow-boat *Fury*, which was then laid up and used as quarters for the men during the progress of the survey.

The field work was completed April 30, and the office work May 30.

High water greatly retarded the work, the banks during the latter part of the survey being under water.

Length of river surveyed, 7.1 miles; transit lines, 11½ miles; stadia lines, 4½ miles; level lines, 8½ miles; soundings, 3,580.

HIGH-WATER GRADES.

A party was at work in May placing high-water and bench marks at various points from Saint Paul to the mouth of the Missouri River. Details of this work may be found under head of Upper Mississippi River.

SURVEY FROM READ'S LANDING TO WINONA.

This survey is now in progress in charge of Superintendent W. A. Thompson. The field work commenced June 1, has been completed from Read's Landing to Chimney Rock, a distance of about 25 miles. It is expected to finish the survey about July 10, when the plotting of the notes in the office will be begun.

VICINITY OF FOUNTAIN CITY, WISCONSIN.

A project for work at Fountain City was submitted March 29, 1888, and approved April 4.

The bar at this locality was very troublesome in 1887; in fact, more so than any other between Des Moines Rapids and Saint Paul. The plan contemplates the construction of three wing-dams extending from Island 60, nearly opposite the upper end of the village of Fountain City, and contracting the water-way at the bar, at a 3-foot stage, to about 800 feet. It is expected that the construction of these dams will remove the obstructions at this point.

These dams are numbered 26, 27, and 28 (Sheet 17) and are to be 620, 498, and 380 feet in length, respectively. They are estimated to contain, including the necessary shore protection, 5,299 cubic yards of rock and 4,616 cubic yards of brush and to cost $10,000. On account of high water in the spring and consequent difficulty in obtaining material, work was not begun until June. On the 11th the snag-boat *Barnard* and steam-launch *Louise* left Heytman's Landing (winter harbor of barge fleet) with eight barges and arrived at Fountain City on the evening of the 12th. The *Barnard* was then laid up and used as quarters for the working force and the towing of material was performed by the *Louise*. The work accomplished to June 30 includes the construction of Dam 26, the upper one of the series, which is 620 feet long, with 160 lineal feet of shore protection, and has three courses of brush and rock its entire length and a fourth course for about one-half its length. It will need some additional top-dressing when the river falls. Dam 27, the second of the series, was commenced, the first course being now completed. It will be 490 feet long, with its crest at an elevation of 3 feet above low water of 1864. The amount of material already put in is: Rock, 2,527.5 cubic yards; brush, 2,432 cubic yards.

It is expected to complete this work in July.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Major A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, March 2, 1888.

MAJOR: I have the honor to present a report of work done under my direction between Otter Island, Illinois, and Montrose, Iowa, under appropriation for "Improving Mississippi River from Saint Paul to Des Moines Rapids," during the calendar year ending December 31, 1887. The items of work and total amounts expended are shown in the following table:

Number.	Designation.	Expended for field work and material.	General superintendent and office expenses.	Charge for use of plant.	Total amount expended.
1	Removing rock, Drew's Prairie	$742.20	$33.07	$129.80	$905.07
2	Repairing Shokokon Dam Nos. 1 and 2	5,541.92	246.94	969.19	6,758.05
3	Repairing Shokokon Dam No. 2	884.51	39.41	154.69	1,078.61
4	Building dam in Wixen Chute	6,094.19	271.58	1,065.79	7,431.56
5	Shore protection, head of Island 395	3,900.17	178.28	697.80	4,866.25
6	Shore protection, Sauerwein's Bend	3,856.28	171.48	674.41	4,702.17
7	Shore protection, Burlington Island	4,972.06	221.68	869.55	6,063.29
8	Work in vicinity of Pontoosac	644.22	28.67	112.67	785.56
9	Removing rock below Island 395	503.88	22.42	88.12	614.42
10	Removing obstructions at Keithsburgh	61.50	2.74	10.76	75.00
11	Closing cut-off, Burlington Island	86.45	3.65	15.12	105.22
12	Removing wrecks	208.44	9.26	36.41	253.71
	Total	27,585.42	1,229.18	4,824.31	33,638.91

1. REMOVING ROCK AT DREW'S PRAIRIE.

This patch of rock had been drilled and blasted in the fall of 1886. Dredge No. 1 was towed to position on the patch May 24, 1887, and worked until June 9, 1887, removing 312 cubic yards of broken rock and gravel. Of this amount 207 cubic yards were rock. A grade line of 5 to 6 feet below low water of 1864 was secured, and a bad obstruction removed from the direct track of steamers. The material forming the patch was ledge rock, bowlders, gravel, etc. The cost of work during the year 1887 was $905.07, and there was expended for drilling and blasting in 1886 $361.76, giving for the total cost $1,266.83, or $4.03 per cubic yard.

2. REPAIRING SHOKOKON DAMS NOS. 1 AND 2.

Work was begun on these dams May 24, and was completed June 2, 1887. There were employed steamer *Vixen*, Dredge No. 1, Pile-driver No. 34. Most of the work

was on Dam No. 1 (Sheet 50*), which was raised with rock to its original height, faced on the upper side with a course of brush, and the latter covered with gravel. The angle between the upper side of the dam and the bottom was also filled with gravel, and the leakage through the dam almost completely stopped. When this work was completed the level of the water above the dam was about 18 inches, and below the dam about 7 feet 2 inches lower than the crest; a fall of 5 feet 8 inches.

The material used was as follows:

Rock, cubic yards (towed 30 miles, from Nauvoo, Ill.)	3,692.17
Brush, cubic yards (towed 14 miles, from Dallas, Ill.)	707.66
Poles, number (towed 14 miles, from Dallas, Ill.)	166
Gravel, cubic yards (towed 6 miles, from foot of Burlington Bluffs)	2,657.60
Piling, lineal feet (towed 10 miles)	3,120.00

The cost of the work, including $1,445.63 paid for rock in 1886, was $8,203.68, or $1.16 per cubic yard.

3. REPAIRING SHOKOKON DAM NO. 2.

September 2 and 3 a small force was sent to repair a bad leak at the east end of this dam, the great head of water having burrowed behind the shore protection and threatening serious damage. On September 19 the dam was reported broken, and on inspection a gap was found 140 feet wide and from 11 to 12 feet deep, through which a large amount of water poured. This was in a part of the dam we had done no work on, it being up to grade. The immediate effect of the break was to lower the surface of the water above the dam all the way up to the head of Burlington Island, from 15 inches at the dam to 6 inches at the upper end. Steps were taken to prevent the break widening by driving clusters of piles at each end of the gap and filling in around them with rock. In these repairs there were used: of rock, 471.60 cubic yards; of spalls, 175.86 cubic yards; of piling, 448 lineal feet.

The cost of the work was $1,078.61 or $1.66 per cubic yard. The rock, as in the former case, was towed 30 miles up-stream.

4. BUILDING DAM NO. 5 [SHEET 62]—VIXEN CHUTE.

The closing of this chute had become a necessity, owing to the great draught of water through it and the shoaling of the crossing opposite Island 394. The least depth of water at the time of beginning the dam was—the stage being 3½ feet—11 feet, increasing to 18 feet at the west end of the dam. The chute at this point being 500 feet wide, a great amount of water was withdrawn from the main channel.

June 7, work was begun by the pile-driver, and a single row of piles 5 feet apart was driven across the site of the dam. Below the piles two mats were sunk, extending across the chute and about 35 feet down-stream, to serve as a foundation and apron. These mats were sunk with rock and covered with rock and gravel, the latter being dumped from dump-scows. When this was completed, rock was thrown from flats laid against the upper side of the piling and on the line of the crest of the dam; while gravel was dumped as close to the rock on the upper side of the dam as practicable, bringing rock and gravel both up together, and thus securing a water-tight joint between the dam and the sand bottom. As the current grew stronger, a mattress was extended above the upper side of the dam against the piling. This prevented any rock from being carried away, as it effectually broke the current.

There is great convenience attached to this mode of construction. Handling the barges is reduced to a minimum, as they will rest against the piling and are held there by the current; except for the lowest or apron course of mattress work, where the barges must be attached below the piles. Also, the piles form a very material assistance to the dam in resisting the attacks of ice, which is one of the worst foes of an ordinary dam of loose stones. During its construction there was no noticeable settlement of the dam in any one place, showing that it was well protected from scour at its base. When completed, Jniy 20, the fall over the dam was 1.8 feet, the stage being 2 feet above low water of 1864. The crest of the dam was then 1 foot out of water, or 3.8 feet above low water. This shows that the effect of this dam extended much further up-stream than the head of Island 394.

The construction of this dam was followed by considerable improvement on the bar opposite Island 394, where many boats had been aground previously.

There were used in the construction of this dam 4,471 cubic yards of rock, 5,412 cubic yards of gravel, 1,360 cubic yards of brush, and 2,359 linear feet of piling. The total cost of the work was $7,431.56, or 66.1 cents per cubic yard of material. A regular brush and rock dam in the same locality would have required about 11,000 cubic yards of material and would have cost probably not less than $10,000.

* Sheet numbers are those *of the general maps*, survey of 1878–'79.

5. BUILDING SHORE PROTECTION AT HEAD OF ISLAND 395.

Steamer *Vixen* was at work here from July 21 to August 12, 1887. Dredge No. 1 was employed four days in July removing snags from bank, and from October 12 to 17 furnishing gravel.

The length of this shore protection is 2,125 feet, and the average width of slope protected is 27 feet. The protection work was done at a very low stage of water. A 20-foot mat was extended from the west side down, and 3 or 4 feet in width of brush was laid on the slope above the water surface. The bank was then riprapped clear to the top. Beneath the water only stone enough was used to sink the mats effectually, and they were afterwards covered with gravel dumped from dump-scows.

The material used was as follows: 2,116.34 cubic yards of rock, 1,780 cubic yards of gravel, and 1,849 cubic yards of brush. The cost of the work was $4,866.25, or 84.7 cents per cubic yard, or $2.29 per linear foot.

6. SHORE PROTECTION AT SAUERWEIN'S BEND.

Work was commenced August 13 and completed September 17, 1887. The same construction as at Island 395, excepting gravel, was used. The width of slope was 21 feet and the length of the protection 2,700 feet.

The material used was as follows: Rock, 2,176.24 cubic yards; spalls, 320 cubic yards; brush, 1,869 cubic yards. The cost of the work was $4,702.17, or $1.07 per cubic yard, or $1.74 per linear foot. The cost of this work, as well as that at Island 395, was increased by the excessive amount of snagging required for clearing the banks.

7. SHORE PROTECTION AT FOOT OF BURLINGTON ISLAND, NO. 392.

Work was begun September 17 and finished October 11, 1887. The construction was the same as the above. The length of protection was 4,700 feet and width 21 feet.

The amount of material used was as follows: Rock, 2,631.46 cubic yards; spalls, 1,037.87 cubic yards; brush, 3,183 cubic yards. The cost of the work was $6,063.29, or 88.7 cents per cubic yard, or $1.29 per linear foot.

8. WORK IN THE VICINITY OF PONTOOSAC.

From July 19 to 22 the drill-boat was employed drilling and blasting high bowlders very dangerous to navigation. August 4 to 7 Dredge No. 1 was employed cutting a channel through Pontoosac Bar and assisting boats over. There was also a sand-bag dam 200 feet long built, which seemed to help considerably in cutting out a channel over the bar. From October 18 to 21 the *Vixen* and dredge were employed removing blasted rocks and snags. Many of the rocks previously blasted could no longer be found, others were covered with sand. The effect of the dynamite on the granite bowlders is to completely shatter them.

There was expended for removal of rock, construction of temporary dam, dredging, and other work mentioned, $785.56.

9. REMOVING ROCK FROM CROSSING BELOW ISLAND 395.

The *Vixen* and dredge worked here from October 22 to 29, taking-out a reef of bowlders and making a good channel, with from 5 to 6 feet at low water. Six hundred and fifty-five cubic yards of rock were dredged, at a cost of $614.42, or 93.8 cents per cubic yard.

10. CHANNEL BELOW KEITHSBURG.

It being reported that boats had struck on rocks in the crossing at the foot of Keithsburg Island, the launch *Lucia* and a drill-boat were sent there October 18. The shifting sand made it impossible to find the rocks complained of, but a number of snags were found and taken out. There are many rocks in the river in this vicinity, and the crossing is a bad one. The chute below Keithsburg should be closed to help the crossing as well as the passage through the bridge.

11. CLOSING CUT-OFF IN BURLINGTON ISLAND.

August 9 a small force was sent to close a cut-off that had formed through Burlington Island, averaging 50 feet wide, and at low-water 3 feet deep. The current in this cut-off was remarkable. Fifty-one and sixty-two hundredths cubic yards

of rock were put in at a cost of $105.22, or $2.04 per cubic yard. At a higher stage of water another dam should be built to close the break half a mile further inland, the water being too low last summer to admit barges to the proper place.

12. REMOVING WRECKS AT HENDERSON AND SKUNK RIVERS.

At both places barges sunk in former years were reported as troublesome obstructions. The snag-boat removed a portion of the barge at Henderson River and the dredge removed the balance, together with a lot of coal, between July 9 and 13. Another barge was taken out by the dredge at the mouth of Skunk River. This work cost $253.71.

GENERAL REMARKS.

Most of the rock used during the season was obtained in the vicinity of Nauvoo, Ill., under formal contract with William Roberts & Co., the price paid being 48 cents per cubic yard on the river bank. Spalls were purchased in open market at 24 cents per cubic yard on bank. Brush was also purchased in open market in the vicinity of Dallas, Ill., the price paid being 28 cents per cubic yard loaded on barges. Poles were purchased for 2½ cents each, and piling cost from 8 to 10 cents per lineal foot, delivered on the river bank.

The long tow, sometimes 30 miles up-stream, which the work, in most of the places entailed, made a double crew on the tow-boat a necessity. The great advantage of the double crew was apparent from the first; the crew, having regular hours, were satisfied and able to keep the boat going at all times. The increase in the effective work of the tow-boat was very marked; and the general results attained show that, with a double crew and plenty of barges, a tow of 30 miles up-stream combined with low water is not incompatible with comparative cheapness of work. It is a decided advantage to know this as, in portions of the river, quarries that would be considered too remote, may, with this knowledge, be put in competition with nearer but more expensive sources of supply.

It was found that the *Vixen* could make two trips per twenty-four hours to Sauerwein's with 250 cubic yards at a trip, and have a little time to spare for towing brush, etc. This distance is about 22 miles. The boat's expenses would average $40 per day with the double crew. Five hundred yards a day is greatly in excess of the amount of stone that can be usually obtained daily; but, supposing it furnished, the cost of towing the 500 yards would only be at the rate of 8 cents per cubic yard.

An estimate of the cost of towing rock from Nauvoo to Sauerwein's Bend, made at the time, showed it actually cost us 12.4 cents per cubic yard; to Shokokon, it cost about 15 cents. The *Vixen*, running night and day, cost from $35 to $42 per twenty-four hours. These figures only include running expenses of the boat, no charge for the use of boat or barges being considered.

COST OF LOADING ROCK.

Various counts were made of the amount of rock that could be loaded per day by one man, and the cost at various places where we hired the work done. The cost varies much with the accessibility of the rock, whether piled or scattered on the hill-side and having to be raked down, as was the case in our quarries at Niota Chute. The following are some of the results noted:

Berger's quarry, Niota Chute.—Rock loaded by days' labor; men boarded by the United States; wheel about 100 feet; rock had to be raked from hill-side and collected; cost from 15 to 17 cents per cubic yard.

Wiegan's quarry, Nauvoo.—Rock loaded by days' labor; men not boarded by the United States; wheel 93 feet for rock and 75 feet for spalls. The loading of the rock cost 8.6 cents and of the spalls 15½ cents per cubic yard.

Roberts's quarries, Nauvoo.—Spawls loaded by Mr. Roberts at 20 cents per cubic yard; wheel over 125 feet.

Roberts's upper quarries, Niota Chute.—Rock loaded by Mr. Roberts at 15 cents per cubic yard. Rock raked down from hillside and wheeled from 100 to 125 feet. At this quarry, on one day, nine men and a foreman, one man piling on barge and eight men loading, loaded 207 cubic yards, the foreman helping occasionally, keeping runs in condition, etc. This is an average of 20.7 cubic yards per man, at a cost of 7.7 cents per cubic yard. But these were selected men, with first-rate barrows and runs. Such a rate could not be maintained. The actual cost to the contractor was figured to be 10 cents.

It is evident from the above that, with a good foreman and tools, and when the United States is not obliged to find quarters for the men and subsist them, the loading of rock can be done for less by the United States than the usual price paid to

contractors, not taking into account wear and tear of tools. Boarding the men is a necessity in some cases, but it is to be avoided when possible.

Men were scarce during the past season, the building of the Santa Fé Railroad absorbing all of the surplus labor, hence the rates paid for labor were a little higher than usual.

I wish to call your attention to the excellent service of Mr. Samuel Edwards, overseer, on whom the detail work and most of the management of the plant devolved. I have to thank his intelligent and efficient efforts for the good success of the season's work, if it should happily be so considered by you.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

THE ADAMS FLUME.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 29, 1887.

SIR: I have the honor to submit herewith the report of the Board of Engineers convened with your sanction, by Special Orders, No. 67, current series, from this office, "to investigate and make report in regard to all matters concerning the work in progress in connection with the practical test of the flume invented by M. J. Adams, provided for by the river and harbor act of August 5, 1886, and also as to the advisability of its continuance," and to commend it for careful consideration. The report is an exhaustive one, covering all the points of the case, and its conclusions as contained in the following extracts are fully concurred in by this office:

Eight years have elapsed since the first appropriation was made for the practical test of the Adams flume; more than $28,000 have been expended upon it; not a foot of the flume has as yet been placed in the river for trial, and there does not appear, at this writing, any probability that the flume, even with the further expenditure of the $15,000 appropriated, will be any nearer readiness for a full test than it now is.

The Board, therefore, after full consideration of the facts in the case, is of opinion that further continuance of this test is not advisable.

It is accordingly recommended that work upon the Adams flume, so called, be terminated without delay, and that the property pertaining to the same and purchased by funds provided by the United States be placed in possession of Maj. Alexander Mackenzie, Corps of Engineers, who will assume charge of it as soon as practicable, making examination of any accounts that may be due and unpaid, and transmitting them to this office with his recommendation as to the propriety of their being paid from the available funds.

The balance available from the appropriation contained in the river and harbor act of August 5, 1886, at this date is $14,143.76, subject to payment to M. J. Adams for September and for liabilities contracted by law and not yet paid.

It is recommended that the balance of the appropriation remaining after providing for liabilities above referred to be applied to the improvement of the "Mississippi River from Saint Paul to the Des Moines Rapids," in accordance with the act of August 5, 1886, which provides for—

Improving Mississippi River from Saint Paul to Des Moines Rapids: Continuing improvement, three hundred and eighty-two thousand five hundred dollars,

* * * and of which sum the further amount of fifteen thousand dollars, or so much thereof as may be necessary, may be used by the Secretary of War, in his discretion, for continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams, but if not so used the sum shall remain as a part of said appropriation, and be used for the purposes first in this paragraph specified.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT, *October* 3, 1887.

The recommendation of the Chief of Engineers is approved.

By order of the Acting Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

SAINT PAUL, MINN., *August* 25, 1887.

SIR: The Board of Officers of the Corps of Engineers, constituted by Special Orders, No. 67, Headquarters Corps of Engineers, United States Army, Washington, D. C., July 16, 1887, to investigate and make report in regard to all matters concerning the work in progress in connection with the "practical test of the flume invented by M. J. Adams," provided for by the river and harbor act of August 5, 1886, and also as to the advisability of its continuance, has the honor to submit the following report:

The Board met at Saint Paul August 15, and having read the letter of instructions from the office of the Chief of Engineers, dated July 25, 1887, and the letter from the same office dated August 10, and examined the papers inclosed in those letters, proceeded to an examination of documents furnished by Major Mackenzie pertaining to the history of the test.

Mr. M. J. Adams, the inventor of the flume, appeared before the Board, as also did Major Mackenzie, upon notification that his presence was necessary.

The Board visited Mr. Adams's shop and yard, situated on the right bank of the Mississippi River a short distance above the head of Frenchman's Bar.

The date of Mr. Adams's invention is not known to the Board. It appears from a report by Major Farquhar to the Chief Engineers March 24, 1879, that as early as 1874 Mr. Adams had invented a machine for the removal of sand-bars from rivers, the machine consisting of a pipe in which was cut a longitudinal slot through which a saw was to project. Mr. Adams proposed to lay a line of this pipe upon the bar to be deepened, and, by working the saw, to stir up the material forming the bar, which would then be carried away by the current. The saw also to be worked by wheels turned by the current. He finally substituted for this a pipe, the under side of which was to be perforated with a number of holes through which he proposed to force jets of water to

inpinge upon and stir up the material forming the bar, leaving to the current the removal of the material. He also proposed to divide the pipe into two compartments, longitudinally, the upper to receive the water, and the lower to receive the perforations through which the jets were to act upon the bar; the upper and lower portions to be connected by valves that could be opened and closed at will. He also proposed to place stop-valves across the pipes so that any portion of the line of pipe could be cut off from that below it. In 1877 he exhibited to Major Farquhar a model of this last-named invention, but showed none of the devices proposed for opening or closing the valves.

Major Farquhar endeavored, without success, to show him the difficulties in the way of successful operation of his invention.

The following description of the invention, probably covering changes to the date of writing it, was given by Mr. Adams in 1886, in a communication "To the chairman and gentlemen of the Committee on Rivers and Harbors" of the last Congress:

DESCRIPTION OF THE INVENTION.

It is a perforated tube about 12 inches diameter, shaped like the letter V, divided into two chambers by a partition, upper and lower. The upper holds the water under the necessary pressure the entire length of the tube. The lower lies quiescent till operations commence. The water from the upper chamber is let through the opening in the partition into the lower chamber and out through the jets, stirring up the sand, holding it in suspense till the current carries it off to some low place, where it forms banks like a canal. The number of jets operating at a time is governed by the pressure. Where there is any obstruction it is opened on it like a battery. No sand, gravel, or moderate hardpan can stand near it. To lay it in one unbroken line in the center of the river from its head to the Gulf it will scour a channel the necessary depth and width throughout and keep it open all through. To give the invention an undeniable test would require about 3 miles, which can be procured from Saint Paul down, it being almost choked in summer. The results of the testing will give a permanent channel the distance laid, removing about 400,000 cubic yards of sand. So that the money expended is covered by a valuable permanent improvement at one-fourth the ordinary cost.

The river and harbor act of Congress approved March 3, 1879, contained the following item of appropriation:

For improving Mississippi River from Saint Paul to Des Moines Rapids, one hundred thousand dollars: *Provided*, That not exceeding twenty thousand dollars thereof may be used by the Secretary of War in his discretion in making a practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams, but without compensation to said Adams for his services: *And provided further*, That such test shall not be made until the right shall be secured to the United States to use said flume in the event of the favorable result of said test upon terms satisfactory to the Secretary of War.

Mr. Adams was authorized by the Secretary of War, April 11, 1879, to proceed with his test in accordance with the terms of the act, and to have uncontrolled application of his device, subject only to inspection during the progress of the test by the officer in charge of the general improvement of the Mississippi River from Saint Paul to Des Moines Rapids, in order that such officer might be enabled to report the effects produced. Mr. Adams, having no pipe or flume in readiness for a test, was obliged to purchase or manufacture it, as well as the attachments, etc.

The locality selected by Mr. Adams for his experiment in 1879, and acquiesced in by the Department, was the shoal between Read's Landing and Wabasha, below the mouth of the Chippewa River.

Mr. Adams, however, not having carried his work far enough to enable him to make any test on this shoal, Major Mackenzie, yielding to

urgent demands of navigation, proceeded in 1881 to improve that piece of river by means of wing-dams. Mr. Adams then accepted Frenchman's Bar for the test. This bar is the first natural obstruction to low-water navigation below the steam-boat landing at Saint Paul, and, as he could readily transport his pipe when finished to that locality, it was regarded as a most convenient point to him for his experiment.

The act of Congress passed August 2, 1882, appropriated—

For continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams, eight thousand dollars.

By the terms of this act no discretion was left to the Secretary of War as to allowing the expenditure of the $8,000. Information regarding the amount of work done upon the pipe, etc., under this appropriation is meager. The two appropriations summed up $28,000.

In the communication to the Committee on Rivers and Harbors, above referred to, Mr. Adams says:

I have completed 4,300 feet of the Adams Flume for establishing a permanent channel in the Mississippi River, costing $9,500. I have also the following property for said flume: $2,000 worth of sheet iron, to make 3,000 more feet; 2 crimping-machines, costing $1,200; punching-machine, $275; diving suit, $670; rubber hose, $400; gaskets, $400; bolts, $120; blocks, $150; barge, boiler, and pump, $2,500; swivels, $250; flanges, $420; boat, $50; forge, $80; elbows, $100; valve bolts, $125; lumber, $200; tools, $300; house and workshops, $900; making a total of about $20,000; the balance of the $28,000 covering labor and incidentals.

Regarding the test under the appropriation of $8,000, Major Mackenzie was instructed by the Department, July 27, 1882, to allow Mr. Adams the use of a small steamer, provided one could be spared for that purpose. Major Mackenzie responded by expressing his desire to aid Mr. Adams so far as was in his power.

The river and harbor act of Congress approved August 5, 1886, contained the following item of appropriation:

Improving Mississippi River from Saint Paul to Des Moines Rapids: Continuing improvement, three hundred and eighty-two thousand five hundred dollars, * * * and of which sum the further amount of fifteen thousand dollars, or so much thereof as may be necessary, may be used by the Secretary of War, in his discretion, for continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams; but if not so used the sum shall remain as a part of said appropriation, and be used for the purposes first in this paragraph specified.

Upon the recommendation of the Chief of Engineers the Secretary of War, on the 14th of August, 1886, directed that Major Mackenzie make an inspection of the work already done by Mr. Adams, and that he obtain from him an explanation of the disposition of the property purchased for the flume test. The result of Major Mackenzie's inspection is given in his report of August 21, 1886. He found Mr. Adams's shop closed, and in the yard and around the shop numerous piles of the special pipe made by Mr. Adams, the total length aggregating about one-half mile; some of the lengths in good condition, others rusted, and a few appearing to be worthless. There was also on the beach an old flat-boat, containing a boiler and a large pump. This inspection afforded the first opportunity of discovering details or methods of Mr. Adams's work. It also led to the discovery that the property purchased by Mr. Adams from the appropriations for the flume test had been mortgaged by him.

Finally, in December, 1886, Major Mackenzie, in accordance with instructions from the Chief of Engineers, dated November 11, 1886, took possession of the property and placed it in charge of a reliable man.

This action brought a protest from Mr. Adams, who claimed the tools and material as his private property.

Subsequently Mr. Adams was allowed access to the property and the free use of the shop and dwelling in order that he might pursue his work, none of the property, however to be removed from the ground excepting by consent of Major Mackenzie.

Upon application by the Secretary of War, the Attorney-General of the United States directed the United States attorney at Saint Paul to guard the interest of the Government in the matter of the attempted sale of the property by the mortgagee. The lawsuit commenced by the mortgagee was dismissed, but the claim upon the property, it is understood, has not been abandoned, and on this account, if for no other, Major Mackenzie felt the necessity of employing a watchman to guard the property.

The Secretary of War, not regarding further continuance of Mr. Adams's work as for the best interests of the United States, authorized the expenditure of the $15,000—which had been conditionally set aside for Mr. Adams's test—upon the improvement of the Mississippi River under the plan then in progress. Subsequently, however, a letter was addressed to the Secretary of War by the Hon. J. B. Gilfillan, member of Congress, under date of February 5, 1887, from which it appeared that Congress intended further expenditure to be made upon the flume.

A revision of the subject led to the conclusion that it was the intention of Congress that the expenditure of the further amount of $15,000, or so much thereof as might be necessary for continuing the test of the flume, as provided in the river and harbor act of August 5, 1886, be permitted, and Major Mackenzie was directed to inspect the work done under the direction of Mr. Adams, as often as might be necessary, and to supervise all necessary expenditures made by him for placing in the water and practically testing the portion of the flume already completed, the Secretary of War desiring to leave the control of the work in charge of Mr. Adams as provided in the act of Congress.

In June last Mr. Adams applied to Major Mackenzie to have a channel dredged in order to facilitate the laying of the pipe, and also wrote him in regard to a contemplated purchase of new valves, elbows, etc., required for furthering the test. To these Major Mackenzie replied, showing his inability to take a dredge off its legitimate work, and also calling attention to the instructions from the Secretary of War that Mr. Adams's work and expenditures were to be limited strictly to such as were absolutely necessary to placing in the water and practically testing the portion of his flume already completed. Major Mackenzie suggested to Mr. Adams that, as there appeared to be little or no portion of his flume in condition for a test, he endeavor to complete and place in the river 500 feet of the flume which, in his opinion, would serve to demonstrate its merits, and that, if the 500 feet operated as successfully as he (Mr. Adams) anticipated, the half mile of pipe could then be put in condition. To this suggestion Mr. Adams finally consented.

It being part of Major Mackenzie's duty, under instructions from the Secretary of War dated June 11, 1887, to examine and report upon the bills incurred by Mr. Adams, an account of the latter against the United States for the month of June, 1887, presented by him in a letter to the Chief of Engineers June 23, was referred to Major Mackenzie for examination and report.

The account, as made by Mr. Adams, is as follows:

Appropriation for improving Mississippi River from Saint Paul to Des Moines Rapids. The United States for that purpose to M. J. Adams, Dr.

1887. For per diem in lieu of personal expenses other than for transportation for self and baggage from city to city while engaged, during the month of June, 1887, in making arrangements preliminary to a practical test of the flume for improving rivers, invented by him:	
1. Thirty days, at $4 per day	$120.00
2. June 8. Railroad fare paid to Washington from Saint Paul, Minn	41.00
3. June 11. Railroad fare paid from Washington, D. C., to Saint Paul, Minn	41.00
4. Horse hire, per receipt	18.00
5. George Greatbush, per receipt	24.00
6. David Pollock, per receipt	24.00
7. Pete Dewey, per receipt	18.00
8. Louis Boidwine, per receipt	10.00
9. Moses Bertrand, per receipt	10.00
10 and 11. Nails and iron, per receipts	5.10
12. Lumber, per receipt	2.25
Total	313.35

The items of this account were reported upon by Major Mackenzie July 9, 1887, showing that the journey from Saint Paul to Washington and return had not been authorized by him; also that the item for horse-hire ($18) was a personal expense of Mr. Adams, and should be covered by his per diem, $4; also that items 5 and 6 were for work on dwelling occupied by Mr. Adams, and therefore did not pertain to the practical test of the flume; and further, that items 4, 5, 6, 7, 8, and 9, which were in the form of receipts and presented as subvouchers, were signed by Mr. Adams instead of by the parties to whom they were due. Of items 10, 11, and 12, $2.40 for iron appeared proper as being for work connected with the flume; the balance of these items being for material used in reconstructing dwelling, and not, therefore, appearing as legitimate expenditures.

Mr. Adams, in his interview with the Board on the morning of August 15, admitted that he had himself-signed the names of the parties to the receipts or subvouchers presented by him as items 4, 5, 6, 7, 8, and 9 of the account. The receipt for horse-hire, signed S. H. Morehead, was for money due J. B. Morehead & Son, whose bill, with true signature to receipt, is with the papers inclosed in the letter of instructions to the Board. It appears that there is no such person as S. H. Morehead engaged in the livery business in Saint Paul.

The Board sees no reason for dissenting from the remarks and recommendations in the report of July 9.

In answer to questions, Mr. Adams said that he did not keep time-books, time-lists, journal, or other books or papers from which to make out accounts in connection with his test. This is certainly not a business-like manner of managing expenditures of public funds, and this fact alone disqualifies him for such a responsibility.

According to the statement furnished the Board from the office of the Chief of Engineers, the expenditures upon the invention, from the first appropriation to July 23, 1887, were as follows:

Per diem to M. J. Adams in lieu of his personal expenses from April 18, 1879, as authorized by the Secretary of War, June 28, 1879	$7,700.00
Railroad fares of M. J. Adams, as authorized by the Secretary of War, June 28, 1879	1,215.46
Purchase of materials, machinery, tools, etc	12,105.94
Compensation of employés	6,010.73
Miscellaneous items, rent of workshop, freights, etc	1,417.37
Total	28,449.50

It is understood that in the original plea for an appropriation Mr. Adams stated his expectation of laying 3 miles of pipe for $75,000. In his communication to the committee of Congress he stated that he had 4,300 feet of the flume completed "for establishing a permanent channel in the Mississippi River," and that the cost of the pipe, tools, barge, boiler, and pump, workshop, labor, etc., had been $28,000.

Finally, in July last, he acquiesced in the proposition of Major Mackenzie to place 500 feet of pipe in the river as a test; but at the time the Board inspected his shop and yard, August 15, there was no evidence that even the 500 feet of pipe would be ready for a test this season. Mr. Adams had two or three men engaged in cleaning a number of lengths of pipe, and had in contemplation the purchase of valves of a new pattern; also some elbows or short-bent tubes one-half inch in diameter, to be screwed into holes in the pipes. There was an old flat-boat on the beach containing a boiler and steam-pump. The tools and materials of various descriptions collected by Mr. Adams seemed, in amount, very inadequate to the sums of money expended for them. Doubtless much of the expense is due to Mr. Adams's manifold changes in plans and details.

In fine, Mr. Adams proposes laying a pipe along the bed of the Mississippi River from Saint Paul to the Gulf. Through this pipe water is to be pumped and means provided for the escape of water through the bottom of the pipe in the form of jets, which, he claims, will remove all obstructions and scour and maintain a wide and deep channel throughout the length of the river. The character of the pipe to be used in practice is not known, and no drawings or detailed description of the same has, so far as known, ever been prepared.

The pipe first proposed by Mr. Adams for the test was of cast-iron, and a considerable amount of it was manufactured in the East, but, so far as known, not accepted or made use of.

The next pipe was made of $\frac{1}{16}$-inch sheet-iron, triangular in shape, and about 12 inches on a side. This pipe, 4,300 feet of which Mr. Adams stated were completed, and which he also says is only for experimental purposes and not such as would be finally used, now lies on the bank at West Saint Paul, a short distance above the head of Frenchman's Bar. The lengths, 10 feet each, are to be connected by bolts and $\frac{1}{4}$-inch rubber washers, which arrangement, he imagines, will afford sufficient flexibility to overcome all changes in direction due to the shape of the river-bed, whether horizontal or vertical, and no matter how sharp they may be. But in fact the pipe will be practically rigid, and this pipe he proposes to lay upon the irregular bed of the river, to rest upon the highest points as well as to cross the lowest depressions, which may be of considerable extent. The pipe is divided into two compartments by a horizontal plate of sheet-iron; the upper compartment is to be continuous throughout the 2,000 miles, or whatever distance may be laid. The lower compartment is divided into lengths of 100 feet, each 100 feet being connected with the upper compartment by valves. Mr. Adams proposes to admit water successively to the lengths of 100 feet through the valves, which are to be operated by means of rods, which, when required for use, are to be raised from the bottom of the river.

The bottom of the pipe on hand was, at first, perforated by a number of very small holes, through which the water was to be discharged; a change in his ideas later caused the substitution of a number of 1-inch elbows for the small holes; these elbows were screwed into the thin sheet-iron, no other hold being provided. A further change in Mr. Adams's ideas resulted in the adoption of one-half-inch elbows placed

at intervals of 1 foot. The changes have resulted in giving the bottom of the pipe a sort of sieve-like appearance. It is now Mr. Adams's idea to close up all of the superfluous holes by inserting in the pipes wooden strips or staves, into which the one-half-inch elbows are to be screwed through the sheet-iron; this arrangement he thinks will secure water-tight joints and prevent the escape of water through the rejected holes. For pumping purposes Mr. Adams has a Worthington pump in the flat-boat before mentioned, which is to force water into the upper compartment of his pipe; he does not think a pressure of more than 5 to 8 pounds will be found necessary. One small pump he expects to perform the work for at least 100 miles of pipe. The water used he claims must be as clear as crystal, any foreign matter affecting injuriously the working of the invention. To secure such crystal water for the pipes he proposes making a reservoir of the flat-boat which carries his pump and boiler, water being admitted to the boat through holes in its sides and bottom. It is understood that no valves for such holes are provided, it being, apparently, Mr. Adams's idea that his pump will force the water into the pipes as rapidly as it enters the barge, thus keeping the latter afloat. It is Mr. Adams's idea that the water, drawn in from the river through holes in the boat, which will necessarily, in most cases, be in shoal water, will be clearer than water which might be brought to the pump by suction arrangements, such as are ordinarily provided for pumps.

It is claimed by Mr. Adams that water forced through his pipe and permitted to work through the last 100 feet, distant about 100 miles from his one small pump, under a pressure of 5 to 8 pounds, will scour a wide and deep channel for such length, and that, by opening the various lengths in succession, such a channel will be secured all along the pipe. How the particular section of pipe in action can settle, with its rigid connections, does not appear. Mr. Adams also claims that, should floods cause the pipe to be buried in the river-bed, the valve-rods can be fished up from beneath the superincumbent mass of sand, the valves opened, the material removed by means of the pump and jets, and the pipe liberated.

Mr. Adams has no plans, specifications, or detailed description of the work he proposes to carry out. Since commencing his work he has made many changes, for which he does not give definite reasons. He has never had and has not now any flume ready for full practical test, and his expenditure of more than $28,000 has been simply in the way of attempts to carry out changeable ideas, and has resulted only in collecting a mass of light iron pipe, mostly in poor condition, not completed, and which he himself considers unfit for anything but experimental purposes. Had Mr. Adams had any definite ideas in regard to the operating his invention, and had his work been managed with any system, a test could have been arrived at several years ago with a small fraction of the money expended.

He has, under the last authority given him, been at work for several months and has not a foot of the flume ready for test.

As to this invention, it is the opinion of the Board that it will not be successful, even upon a small scale, to say nothing of the idea of maintaining a channel of width and depth sufficient for navigation from Saint Paul to the Gulf of Mexico by means of an unbroken line of pipe laid in the middle of the river between those points. It is not doubted that water forced through perforations in a pipe laid upon a sand-bar will loosen more or less of the sand close to the pipe and that, if the current of the stream be sufficiently strong at the particular point where the

jets act, it will move the sand thus loosened or stirred up; but in wide portions of the stream there is not always sufficient current to move light sand. It is consequently in such parts of the stream that sand-bars are generally found, and if the natural currents of the river over the entire width of channel, as well as in the vicinity of the pipe, and under the influence of which the sands are deposited and bars formed, are not increased materially in velocity or carrying capacity by the use of this flume it can not be seen how the sands will be removed from the bars, even after being stirred up by the action of the jets, for these jets have no transporting effect. The sand then, will immediately fall back upon the bar, in the vicinity of the narrow pits or trenches from which it is removed by the action of the jets. In crossing sharp depressions of considerable length in the bed of the river the rigid pipe will most probably break under its own weight, and large portions of the pipe will be deeply buried under masses of sand after every heavy flood.

The Boulogne experiment, made in 1877, and to which Mr. Adams's communication to the committee evidently refers, was on a small scale, being made with a single pipe about 300 feet in length, and was not unqualifiedly successful.

The experiment demonstrated that, even for the comparatively short bar, a number of parallel lines of pipe would be needed for a satisfactory trial. For scouring this bar there is a tidal reservoir close at hand, of 1,000,000 cubic meters capacity, the contents of which are suddenly discharged upon the bar at time of low tide. There is no record, so far as the Board is informed, that the French Government ever repeated the experiment.

Eight years have elapsed since the first appropriation was made for the practical test of the Adams flume; more than $28,000 have been expended upon it; not a foot of the flume has, as yet, been placed in the river for trial, and there does not appear, at this writing, any probability that the flume, even with the further expenditure of the $15,000 appropriated, will be any nearer readiness for a full test than it now is.

The Board, therefore, after full consideration of the facts in the case, is of opinion that further continuance of this test is not advisable.

As bearing upon the subject, four inclosures are herewith marked * Appendixes A, B, C, and D.

Respectfully submitted.

CHAS. J. ALLEN,
Major of Engineers.
H. M. ADAMS,
Major of Engineers.
WM. H. MARSHALL,
Capt. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Y 4.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

At the beginning of the year there was on hand a balance of $29,124.40, but of this amount $25,000 was applicable to the construction of a pier below the Des Moines Rapids Canal, leaving but $4,124.40 available for work under the project for completing the Des Moines Rapids improvement.

During the past year 649.38 cubic yards of riprap face stone were

* Omitted.

purchased under contract with Patterson Bros., and 2,143 square yards yards of slope wall were laid.

The work is under the immediate supervision of Mr. M. Meigs, United States civil engineer.

The work yet remaining to be done to complete this improvement in accordance with the project, which has received the approval of Congress, is a small amount of blasting and dredging in the channel above Nashville, raising lock-walls 4 feet at lower and middle locks, refilling and completing paving of canal embankment, building a sluice for removing sediment, building an office at the lower lock, and completing the lock grounds.

In the construction of the dry-dock at the Des Moines Rapids Canal, the openings for emptying the dock have been made very large, with a view to sluicing through them the muddy water which comes into the canal from Price's Creek during freshets. It is thought that these openings will serve as one of the sluice-ways heretofore projected for assisting in removing mud brought into the canal by the creeks.

The enlargement of the sluices of the dry-dock has added about $8,000 to the cost of that work, but has resulted in reducing the estimate for completing Des Moines Rapids improvement $20,000, a saving of $12,000, which amount is now deducted from amount required to complete work. As a result of the increase of sluices of dry-dock, it is possible the ultimate cost of the work may slightly exceed the original estimate, and if so it seems proper that such extra cost should be borne by the Des Moines Rapids improvement. For this reason, the item of $8,000 is retained in the estimate, to be applied to work pertaining to the dry-dock, if it prove necessary.

There is now available "for pier construction in extending the outer wall of canal to the pivot-pier of bridge" at Keokuk $25,000; but no work on a pier has been commenced, for the reason that the amount on hand is not sufficient to justify the commencement of any pier that will stand in the location proposed. It is hoped that no further allotments for a permanent pier may be made, it being believed that the same would be an unnecessary expenditure of money. But such action is recommended as will permit the construction of a floating boom, as desired by the entire river interest and as suggested by the War Department, a cheaper structure, and one which will far better serve the interests of navigation. This matter is referred to in Senate Ex. Doc. No. 72, Forty-ninth Congress, second session. When legislation permits the construction of a floating boom in place of the fixed pier, at least $10,000 of the amount now applicable to the pier will be available for work under approved project, and the amount required to complete work can then be reduced by that amount.

The fact that an appropriation has been made for this pier has made it inexpedient to call on the company owning the Keokuk Bridge for such work, under section 8 of the river and harbor act of July 5, 1884, as has been required at the hands of the companies owning other bridges over the Upper Mississippi River. And this is somewhat unfortunate, as at no point is work more desirable. The Keokuk Bridge, unfortunately for the interests of navigation, was built at the foot of the Des Moines Rapids, with the draw below and but a short distance from the lower lock of the canal; and the bridge company have added additional difficulties by letting portions of the long pier go to ruin.

The dangers to navigation due to the unfortunate location of the Keokuk Bridge can probably be overcome to as great an extent as is practicable by the construction of the floating boom recommended by the War Department. *And if authority be granted* for such construc-

tion by Congress the boom can be quickly constructed without furth appropriation of money, and immediate relief will be given, whereas, the construction of a pier be required, it is probable the interests navigation will still have a long time to wait for the relief they are justly entitled to.

There has been allotted and appropriated for the improvement of t Des Moines Rapids, including $25,000 for the pier at the foot of t canal, the sum of $4,517,950. There have been expended by vouch to date $4,492,835.09, and the net cost of the work to the United Stat considering $125.25 received from sale of fuel and $1,019.12 repaid the Treasury, has been, to June 30, 1888, $4,491,690.72. These expen tures include the cost of operating the canal for the time previous the making of special appropriations for such purpose.

There is required to complete the improvement, in accordance w approved project, $68,495. This amount includes $25,000 which is add to replace the amount allotted by Congress from previous appropr tions for pier construction. If further allotments for the pier are ma the amounts must be added to the estimated amount required for co pleting improvement in accordance with existing project.

The completion of this work has been greatly delayed by the comp atively small appropriations allowed for a number of years. And t delay has increased the cost of the work. It is desirable in the inter of economy that the amount required for completion be given in a s gle item.

ABSTRACT OF APPROPRIATIONS.

By act approved June 23, 1866	$200,
By act approved March 2, 1867	500,
By act approved July 25, 1868 (allotment)	300,
By act approved April 10, 1869 (allotment)	178,
By act approved December 23, 1869	200,
By act approved July 11, 1870	400,
By act approved January 18, 1871	341,
By act approved March 3, 1871	250,
By act approved June 10, 1872	400,
By act approved March 3, 1873	400,
By act approved June 23, 1874	400,
By act approved March 3, 1875	480,
By act approved August 14, 1876	230,
By act approved June 18, 1878 (allotment)	62,
By act approved March 3, 1879	25,
By act approved June 14, 1880	20,
By act approved March 3, 1881	25,
By act passed August 2, 1882	30,
By act approved July 5, 1884	50,
By act approved August 5, 1886	26,
Total	*4,517,

Money statement.

July 1, 1887, amount available	$29,12
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,88
July 1, 1888, balance available	25,24
Amount appropriated by act of August 11, 1888	35,00
Amount available for fiscal year ending June 30, 1889	60,24
Amount (estimated) required for completion of existing project	33,49
Amount that can be profitably expended in fiscal year ending June 30, 1890	33,50

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

This amount includes $25,000 set aside by Congress for construction of a pi foot of canal.

Y 5.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

The Des Moines Rapids Canal was open for navigation during the past year 227 days, during which time there passed through it 595 steam-boats and 235 barges, carrying 8,330 passengers, 33,160 tons of merchandise, and 143,037 bushels of grain. There also passed through 166,827,752 feet of lumber, 34,505,000 feet of logs, 49,848,840 shingles, and 83,642,450 laths. The high water of 1888 permitted boats and rafts to pass over the rapids outside of the canal, but the continued low water during the summer and fall of 1887 compelled all boats and rafts to use the canal, and the year's lumber business is about the largest on record.

Less material than usual was brought into the canal during the past year, but surveys show that a general filling of the canal is going on, and that the annual amount of dredging must be increased. A tow-boat, pertaining to the general improvement of the Upper Mississippi, has been available for use in connection with dredge during the past year. It will probably, in the future, be necessary to build or purchase a tow-boat for use in connection with the dredging operations at the canal.

A floating boom was constructed during the past year and placed in position against the four cribs located above the guard-lock, for facilitating entrance to the canal.

The river reached its highest stage for the year on May 16, 1888, when, at the lower-lock, it stood at 19.65 feet above the low water of 1864, being within 1.23 feet of the high water of 1851, which is the highest water recorded at Keokuk.

This extreme high water severely tested the canal embankment, and if it had continued longer serious results might have followed. Some portions of the bank are built of poor material and much repair and rebuilding must be done before the bank can be considered safe against recurring floods.

Extensive repairs to lock gates were made during the year, but in the course of a few years some of the gates must be replaced by new ones. At most of the gates, spars, operated by hydraulic machinery, have been substituted for the opening and closing gear formerly in use, and they are working very satisfactorily.

Much repair work, pertaining both to canal and general improvement of upper river, has been carried on in the canal machine-shop during the past year. This shop is a frame structure and quite old. It is desirable that a more substantial fire-proof building be erected, as soon as practicable, to serve as a machine-shop and store-house for patterns and other material.

The operating and care of the canal are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report, giving detailed operations of the year, is appended.

Tables are given with this report which show: 1. Expenditures for fiscal year ending June 30, 1888; 2. Traffic statement for fiscal year ending June 30, 1888; 3. Comparative expenditures for operating and care of Des Moines Rapids Canal for fiscal years 1882 to 1888; 4. Comparative traffic statement showing the total traffic that has passsd through the canal since its opening in 1877.

The expenses of operating and care are now provided for by a indefinite appropriation made by an act of Congress of March 3, 1881.

The original estimate for operating and care was $40,000 per anı and with all parts of the canal in good condition, the expenses ca reduced considerably below this amount. But so long as the ite dredging remains as large as at present, and when it is necessa replace worn out parts or appliances, the expenses will necessaril increased beyond the original estimate.

The project for last year contemplated the expenditure of $45,00 operating expenses and $2,200 for boom construction. The allotı for repairs was somewhat increased over estimate, owing to exte repairs to gates; but the total expenditure, owing to saving in dred item, has been kept within the estimate.

The expenses for the fiscal year ending June 30, 1889, includin item of $15,500 for dredging, are estimated at $45,000.

Abstract of appropriations.

By act approved—	
April 30, 1878	$
June 18, 1878 (allotment)	3
March 3, 1879	4
June 14, 1880	3
March 3, 1881, for fiscal year ending June 30, 1882	4
March 3, 1881, for fiscal year ending June 30, 1883	7
March 3, 1881, for fiscal year ending June 30, 1884	4
March 3, 1881, for fiscal year ending June 30, 1885	4
March 3, 1881, for fiscal year ending June 30, 1886	4
March 3, 1881, for fiscal year ending June 30, 1887	4
March 3, 1881, for fiscal year ending June 30, 1888	4
Total	4

Money statement.

July 1, 1887, balance on hand	$1,
June 30, 1888, amount drawn from Treasury under indefinite appropriation	42,
	43,
June 30, 1888, amount expended during fiscal year	42,
June 30, 1888, balance on hand	1,

Month.	[illegible]				Canal and locks.				[illegible] 30, 1888. Dredging canal.					
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.	Labor.	Supplies.	Current repairs.	Total.	Boom above guard-lock.	Grand total.
1887.														
July	$375.00	$2.00	.....	$377.00	$1,375.00	$114.66	$69.12	$1,558.78	.....	.....	$322.26	$322.26	.....	$2,258.04
August	375.00	1.55	.....	376.55	1,375.00	55.48	628.52	2,059.00	.....	$19.80	13.70	33.50	.....	2,469.05
September	375.00	79.20	$76.70	530.90	1,468.67	385.71	321.86	2,176.24	.....	62.57	66.54	129.11	.....	2,836.25
October	375.00	19.35	21.44	415.79	1,415.00	85.62	1,188.94	2,689.56	.....	10.00	12.71	22.71	$926.47	4,054.53
November	840.00	3.75	21.44	865.19	1,453.33	272.50	839.45	2,565.28	$711.65	363.67	14.32	1,089.64	269.53	4,800.64
December	540.00	2.60	104.58	647.18	1,362.65	235.64	776.23	2,374.52	75.00	.....	44.71	119.71	.....	3,141.41
1888.														
January	475.00	2.00	21.44	498.44	1,303.33	135.38	915.15	2,353.86	240.00	127.59	11.34	378.93	.....	3,231.23
February	375.00	31.67	47.92	454.59	1,285.67	128.99	343.45	1,758.11	240.00	.....	94.05	334.05	.....	2,546.75
March	375.00	1.75	123.53	500.28	1,366.67	150.32	518.93	2,035.92	175.00	30.18	454.49	659.67	18.12	3,213.99
April	640.00	.....	.....	640.00	1,614.50	226.62	437.27	2,278.39	1,166.62	772.36	430.50	2,369.48	93.20	5,381.07
May	.....	10.17	.....	10.17	1,447.00	74.84	1,230.09	2,751.93	1,139.34	308.17	213.33	1,660.84	.....	4,422.94
June	125.00	.....	64.65	189.65	1,426.00	77.18	703.28	2,206.46	1,337.16	573.28	130.90	2,041.34	.....	4,437.45
Total	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,808.05	5,084.77	2,267.62	1,808.85	9,161.24	1,327.32	42,802.35

Traffic statement of the Des Moines Rapids Canal for the year ending June 30, 1888.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Lath.	No. of lockages.
1887.					*Tons.*	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	53	64	21	2,977	4,384	54,600	38,901,000	8,065,000	18,927,500	11,540,950	361
August	54	52	44	1,537	3,207	6,220	30,403,850	5,690,000	18,113,700	9,708,500	281
September	49	50	41	709	3,143	27,050	38,099,088	4,750,000	20,338,250	12,087,900	315
October	61	59	29	5[illegible]0	2,887	16,525	50,064,228	10,640,000	22,815,750	13,813,750	397
November	30	32	30	157	1,314	18,575	9,359,586	5,360,000	3,447,250	2,697,740	210
1888.											
April	35	16	35	58	8,208	1,800	.....	.....	.....	.....	79
May	12	.....	6	.....	2,065	.....	.....	.....	.....	.....	.....
June	17	11	29	2,372	7,952	18,267	.....	.....	.....	.....	106
Total	311	284	235	8,330	33,160	143,037	166,827,752	34,505,000	83,642,450	49,848,840	1,749

Comparative expenditures for operating and care of Des Moines Rapids Canal for fiscal years 1882 to 1888.

Year.	Office and administration.				Canal and locks.				Dredging canal.					Miscellaneous.	Grand total.
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.	Labor.	Supplies.	Repairs.	Contract.	Total.		
1882	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79	$2,340.43	$572.09	$446.58	$14,080.39	$17,839.49	*$668.75	$47,053.34
1883	4,821.12	289.86	449.52	5,560.50	25,813.49	2,216.87	3,203.01	31,233.28	4,765.93	1,538.80	598.04	30,666.17	37,568.94	*3,564.07	77,926.70
1884	5,045.22	209.12	665.62	5,919.96	17,654.23	4,344.51	1,291.20	23,289.94	7,485.45	4,789.32	1,262.02	.....	13,536.79	*536.73	43,283.42
1885	5,015.00	245.41	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77	3,353.12	8,580.69	1,888.73	.....	13,822.54	.....	44,506.50
1886	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86	4,984.55	3,017.49	3,530.41	.....	11,532.45	.....	43,009.53
1887	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62	6,149.45	3,810.12	2,453.98	.....	12,413.55	.....	42,152.84
1888	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,808.05	5,084.77	2,267.63	1,808.85	.....	9,161.24	†1,327.32	42,802.35

* Machine-shop. † Boom above guard-lock.

Comparative traffic statement, showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockages at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	*Number.*
1878	670	548	.....	53,346	737,415	25,000,000	.....	4,000,000	3,700,000	824
1879	802	454	5,008	64,658	2,192,642	33,347,612	8,086,000	8,721,796	11,749,000	1,564
1880	967	651	13,231	78,989	2,197,469	21,832,478	13,160,960	27,863,640	30,561,000	2,497
1881	840	276	10,003	44,962	1,154,092	52,256,235	11,013,410	11,657,655	15,091,000	1,339
1882	760	444	8,588	29,043	781,817	17,170,011	4,475,000	3,112,825	4,885,250	2,292
1883	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	11,558,000	4,435,000	1,353
1884	913	245	13,057	54,215	470,580	57,018,151	9,399,764	15,924,645	25,182,250	1,906
1885	889	169	13,065	54,120	776,432	43,119,797	2,779,670	13,473,205	25,018,750	1,970
1886	784	218	22,221	56,001	465,681	22,769,823	2,195,360	4,002,800	8,253,000	755
1887	990	318	20,797	52,815	366,432	178,754,876	24,827,000	49,961,781	90,459,922	1,717
1888	595	235	8,330	33,160	143,037	166,827,752	34,505,000	83,642,450	49,846,840	1,749

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, June 30, 1888.

MAJOR: I have the honor to make the following report on "Operating and care of Des Moines Rapids Canal" for the fiscal year ending June 30, 1888.

The canal was open to navigation two hundred and twenty-seven days and closed one hundred and thirty-nine days. The canal was closed seven days on account of high water and one hundred and thirty-two days during the winter season.

The past fiscal year has been marked by both extremely high and extremely low water. The lowest water occurred August 10–13, 1887, and the highest stage was reached May 16, 1888, when it stood at 19.65 feet above low water of 1864 at the lower lock and 12 feet at the guard-lock. This high stage at the lower lock is 1.23 feet below the higest water of 1851 (the highest stage recorded), and is also 0.7 foot higher than the highest of other recorded stages since 1851; that is, for the last 37 years.

The high water put a severe test on the canal embankment, which, under the great head of water (about 9 feet at the guard-lock), showed signs of weakness, and, at one time, a portion of the embankment 50 feet long gave way, the slope wall on the inside sliding into the canal and the water oozing through the bank as through a sponge. Fortunately, a large force of men being on hand at the time and engaged in strengthening the bank, by a liberal application of rock taken from other portions of the embankment the break was stopped before any great damage resulted. Levels taken at intervals of 500 feet show that there has been a gradual creeping or subsidence of the slope wall for a distance of 3 miles below the head of the canal, amounting to from 6 to 12 inches. The inside wall seems to be too steep and the toe on the inside should be weighted with stone to prevent any further movement of the revetment. This will require about 4,195 cubic yards of rubble-stone, costing, in place, about $5,243.75. The work done in past years of filling the low places in the embankment was quite justified by the high water just passed. Had not this work been done, the water would have in places stood 2 feet higher than the bank.

From April 30 to May 30, thirty days, the lower lock was submerged and at the highest stage attained the depth over the coping of the lock walls was 3.09 feet. The lock was for a time accessible only by skiffs, as the railroad track between the lock and the mainland was completely under water. But little damage was done to the Government property.

REPAIRING CANAL EMBANKMENT.

The extreme high water, as above stated, inflicted considerable damage on the em bankment above Sandusky, and a large force of men was kept at work strengthening the weak places and patrolling the bank to watch for leaks as they occurred. In some places the bank built of black loam became spongy and water-logged, but, except in the instance previously noted, there was no actual break, though water could be heard in many places trickling through the bank.

DREDGING CANAL.

The very low water, extending from July 1 to October 30, 1887, was accompanied by a general drought, and there were very few storms such as bring deposits into the canal. This fact and the choking of the canal with rafts of logs and lumber made it advisable to put the dredge at work elsewhere during the summer.

A survey of the canal was made in April, 1888, and a comparison with that of 1882 shows that, outside of the restricted areas about the mouths of creeks, etc., which discharge into the canal, the general bottom has been filled up on an average 12 inches or more. It is important that this gradual filling, already in places as much as 2½ feet above grade, should be kept down, and that the dredge should be kept continuously at work, if possible, independent of outside tow-boats. I would therefore suggest that $14,000 be asked for to build a suitable tow-boat to belong to the canal. The one at present in use has hardly power enough for towing our heavy dump-boats on the rapids.

A double crew was worked night and day during the months of April and May, 1887, taking out about double the ordinary output of the dredge. It is proposed to continue this method the coming year.

There were removed from the canal during the past fiscal year 47,333 cubic yards of material.

REPAIRS TO FLAT-BOATS, DREDGE, ETC.

The usual current repairs were made from time to time as required. The coal flats Nos. 1, 3, 5, 6, 7 were partially rebuilt, and, though some of them are twelve to fif-

teen years old, are in passable condition. The four dump-boats, now three and a half years old, begin to show signs of age and hard work, but will probably last several seasons yet. The posts of the fences at the lower, middle, and guard locks having rotted off in the course of years, and the fences blowing down in consequence, were replaced with new ones.

BOUNDARIES TO CANAL PROPERTY.

Nothing has been done as yet to mark these boundaries. The question of title to certain portions of the canal property occupied by the Chicago, Burlington and Quincy Railroad Company should in my opinion, be submitted to the Department of Justice for settlement. The railroad appears to have an equitable right of occupancy, but not a title, the same being vested in the United States by purchase.

REPAIRS TO LOCK GATES AND MACHINERY.

Repairs to lock-gates were completed in March, after great difficulty on account of extreme cold weather and unfavorable stage of water. Four new spars were bought and placed as follows: One at guard-lock, upper west gate; 2 at lower gates of middle lock; and 1 at the lower east gate at lower lock.

All the larger gates of the locks, except the lower gates at the guard-lock, are now converted, as regards their opening and closing mechanism. to the spar system, which works with certainty and the minimum of trouble and repair.

At the guard-lock the increasing trouble with the chains at the lower gates makes it advisable to convert their operating mechanism to the spar method; and, if necessary, it is intended to do this during the coming winter.

MACHINE SHOP AT LOWER LOCK.

During the winter months four lock engineers and two carpenters (one a lock-master) have been employed steadily on various repairs to machinery of the locks, United States dredge, and tow-boats belonging to the canal and other Government works. Two electric-light engines were built for use on steamers *J. G. Parke* and *General Barnard*. The dynamo at the lower lock, having been burned out, was rewound and made as good as new.

The machine shop has become almost indispensable. Since it was started in 1883 the amount of work done there by the regular lock employés amounts, at the usual wages paid outside machine shops, to $26,524.86.

The old wooden building, built originally of second-hand material, should be replaced by a brick structure, fire-proof, with a loft for the lock machinery patterns, which are in constant requisition and of which many thousand dollars' worth are now stored in wooden sheds close to the railroad track and liable to be burned by sparks from passing locomotives. It is estimated that $3,500 would furnish a suitable building with iron roof and shutters. The present building, constructed of rough boards and battened, will soon be unfit for use as a machine shop, as it is deficient in light and space for carrying on work economically and is also very cold in winter.

OFFICE BUILDING.

A proper office building for the canal has been mentioned in former reports as being greatly needed. The present office is many blocks from the canal, inconvenient and expensive.

BUSINESS OF THE CANAL.

Low water during the whole of the summer of 1887 and the great number of rafts passing throug the canal have made the season's report about the largest on record, though the long-continued high water of 1888 greatly reduced the amount of business that would have been done. In May, 1888, but twelve boats passed through the canal.

BOOM ABOVE GUARD-LOCK.

The boom authorized by the project for last fiscal year was built and put in position. The cost in place was $1,327.32. This boom gives general satisfaction and makes the

entrance to the guard-lock both easy and safe. A small suspension foot-bridge, with 54 feet span, connects the piers against which the boom rests with the upper end of the guard-lock.

* * * * * * * *

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 6.

DRY-DOCK AT DES MOINES RAPIDS CANAL, MISSISSIPPI RIVER.

A history of this work was given in my annual report for the fiscal year ending June 30, 1886.

At the beginning of the year there was available for work the sum of $27,621.76, all of which has been expended. During the past fiscal year the masonry has been been completed and gates almost finished. The work remaining to be carried out and completed is as follows: The slope wall of dock, the concrete bottom and arrangements of walls and blocking for supporting boats, the 18-inch drain culvert connecting dock with lower level of canal, placing pumping engine, gates, and the removal of a portion of the canal bank.

A detailed statement of work done during past year and its cost is given in the appended report of Mr. M. Meigs, under whose supervision the dock is being constructed.

The original plan for sluice-gates in the outer embankment of the dry-dock has been modified so as to increase their capacity. As now constructed this sluice will probably take the place of one of the sluices heretofore proposed for assisting in removing sediment from the canal. This change in plan increases the cost of the dry-dock about $8,000, but effects a saving of $20,000 in the completion of the Des Moines Rapids improvement. If, owing to the increase in capacity of the dry-dock sluices, the total cost of work is made slightly greater than the original estimate, it seems proper that such excess in cost should be borne by the appropriation for the improvement of the Des Moines Rapids.

There have been appropriated for this work and expended on it $108,750, and there remain to be appropriated in accordance with original estimate $16,250. Economical construction requires that this amount be given in one appropriation.

The large plant owned by the United States and used in connection with the improvement of the Upper Mississippi River will make use of this dock, and the longer its completion is delayed the greater will be the expenses attending the repair and keeping of this fleet in proper condition. The dock will also be of great benefit to the entire commerce of the Upper Mississippi River.

Abstract of appropriations.

By act passed August 2, 1882	$30,000
By act approved July 5, 1884	30,000
By act approved August 5, 1886	48,750
Total	108,750

Money statement.

July 1, 1887, amount available	$27,621.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	27,621.
Amount appropriated by act of August 11, 1888	16,250

REPORT OF MR. M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 188

MAJOR: I have the honor to submit the following report on constructing a d dock at the Des Moines Rapids Canal, Mississippi River, for the fiscal year end June 30, 1888.

Work was carried on from June 30, 1887, to November, 1887. All the masonry the entrance to the dock was completed. Slope wall was laid in the prism of dock to about the 8-foot stage in the canal. Most of the steps were cut and plac and the miter-sill bolted down. The miter-sill and breast-wall and the west w wall have been built; sluice-gates made and set in place; a 12-inch rotary drain pump put in complete order and set in well. The heel posts and cushion sticks of main gates are in place, lumber and other materials are on hand, and the constr tion of the gates is well under way.

The iron heel posts and the other castings for the gates were made by the Nove Iron Works of Dubuque, Iowa. All bar iron, angle iron, etc., for gates were f nished by the Union Iron Mills of Pittsburgh, Pa., and all eye bars were made by Keystone Bridge Company of Pittsburgh, Pa.

All contracts have been closed and there are no outstanding liabilities.

* * * * * * *

There remains at present to be finished, concrete foundation of dock bottom, l ing an 18-inch drain culvert to lower level of canal, placing pumping engine, rem ing the old canal bank above the dry-dock, timber blocking for support of bo when docked, completing slope walls of dock and laying steps, and completing ga

Low water made the towing of stone over the rapids from the quarry very diffic and dangerous. One barge was sunk but raised again at small expense. The c tinued low water from July to November made it necessary to load the barges to o about one-half their capacity and double the number of trips of the tow-boat.

Material received and work done.

Stone received:		
Face	cubic yards	570
Backing	do	925
Riprap face	do	207
Stone cut	do	624
Stone laid:		
Masonry	do	2,232
Riprap face	do	147
Earth excavated	do	1,713
Rock excavated	do	272

The following is an itemized statement of expenditures:

Purchase of stone	$12,479
Purchase of cement	772
Purchase of tools	26
Cutting stone	4,646
Laying stone and slope wall	3,009
Excavation for foundations	1,053
Bailing and draining	1,189
Repairs of barges and launch	397
Towing stone	1,197
Lumber for gates	640
Iron for gates	2,046
Overseer at works and contingent expenses	772
General superintendence and office expenses	162
Total	28,395

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Enginee

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 7.

ICE-HARBOR AT DUBUQUE, IOWA.

A full description of this work has been given in previous reports.

At the beginning of the year there was available a balance of $4,503.99. No further work has been carried out, and this balance is still on hand.

To complete the harbor in accordance with original project calls for the riprapping of the south shore of the harbor, and the balance on hand would probably accomplish such work; but an item in the last river and harbor act provides that "the unexpended balance, or so much thereof as shall be necessary, shall be applied to paving instead of riprapping said harbor." For such paving and the grading which must precede it additional appropriations are necessary. The intention of Congress not being fully understood, new plans or estimates can not well be prepared. While the paving work referred to is not a necessity, so far as the use of the harbor for its legitimate purposes is concerned, it would be a desirable method of finishing the work, if funds are available for such purpose.

The balance now available will be retained for commencing any work which may hereafter be determined to be the best for completing the ice-harbor. As the dredging of the harbor has been completed, the delay does not materially interfere with the use of the harbor during the winter.

Abstract of appropriations.

By act passed August 2, 1882	$20,000
By act approved July 5, 1884	20,000
Total	40,000

Money statement.

July 1, 1887, amount available	$4,503.99
July 1, 1888, balance available	4,503.99

Y 8.

HARBORS OF REFUGE ON LAKE PEPIN, AT LAKE CITY, MINNESOTA.

A survey for harbors of refuge on Lake Pepin, called for by act of Congress, was made in 1881, and certain plans and estimates were presented.

Acts of Congress of August 2, 1882, July 5, 1884, and August 5, 1886, appropriated and allotted, in all, $35,000 for the work at Lake City.

The earlier appropriations were not sufficient in amount to justify a commencement of work, and after the appropriation of August 5, 1886, was made it was concluded that a less expensive and extensive structure than that originally contemplated was desired by Congress. New plans were therefore made and new projects presented in July and August, 1886. These projects were approved.

The later projects provided for the building of a pier about 800 feet long, from a point on the shore below the gravel point rather than above it, as originally proposed.

In the fall of 1886 some preparations were made for commencing work; but, in consequence of strong protests from some of the residents of Lake City as to location, operations were suspended. Later, the differences were reconciled, and by the voice of the city council the Government was asked to locate the work where, in its opinion, it would best serve the interests of commerce.

The new plans contemplated the building up of a foundation of gravel, which would serve to so reduce the depth of water and amount of crib-work as to permit a useful length of pier to be built. On the 23d of May, 1887, a dredging outfit was sent to Lake City and the foundation was commenced. Work was continued through the season and resulted in the construction of a pier extending into the lake from the foot of Elm street about 871 feet, of which length 512 feet are of crib-work, and the balance earthen embankment. The crib-work rests on a gravel foundation, which reduced the depth of the lake on the line of the pier from 28 feet to about 5 feet at low water.

The crib-work was built with sloping side and end, and this plan proved itself to be much better than that of vertical sides, as used at Stockholm. During the past spring there was an unprecedented combination of very high water, solid ice, and severe storms which materially damaged the Stockholm pier and destroyed much private property; but the pier at Lake City was, so far as can be now discovered, only slightly injured by the tearing away of its top planking.

This pier, during the time of high water and storms, furnished protection to the shops and warehouses in the harbor and saved from destruction property valued at a far greater amount than the cost of the pier.

A record and description of the work is given in the following extract from the season's report of United States Superintendent W. A. Thompson, under whose immediate direction the operations were carried out:

Owing to the depth of water being from 20 to 28 feet at low-water stage for most of the length of the proposed pier, it was decided to lessen the cost by making a foundation of gravel, dredged from the gravel bars in the vicinity of Lake City. Accordingly, I was instructed in April, 1887, to get the dredge *Phœnix* and outfit ready to do this work as soon as possible. The outfit, consisting of dredge, tow-boat *J. G. Parke*, six dump-boats, and two coal-flats, reached Lake City Saturday, May 21, and began work May 23. Various bars within a distance of 4 miles of Lake City were examined, but none were found to contain a better gravel than could be found in front of the steam-boat landing.

During the month of June the dredge was necessarily taken away from Lake City and put to work between Saint Paul and Hastings, dredging new channels through bars that obstructed navigation. Work was resumed at Lake City July 5. August 10 the dredge was taken to Beef Slough and returned August 14, and continued to work at Lake City until November 3, when it was laid up at Read's Landing.

During a portion of September and all of October the tow-boat was engaged a greater part of the time in towing rock, and consequently but little work could be done by the dredge.

For a distance of 355 feet from the shore as much gravel was deposited as was possible, and for the rest of the distance the gravel foundation was raised to within about 5 feet of low water of 1864. The slopes of the sides of the foundation are about 4 feet horizontal to 1 vertical.

The gravel embankment at the shore end is 17 feet wide on top, with a height of 13 feet above low water of 1864. The gravel was deposited under water by means of dump-boats, and for that part above water the gravel was wheeled onto the embankment from flat-boats.

The slopes above low water are 1½ horizontal to 1 vertical. On the lower slope, *there is a layer of* rock 2½ feet thick at the bottom, decreasing to 1 foot in thickness

at the top. On the upper side the rock is 1½ feet thick at base, and 1 foot at the top. The top of the embankment is also covered with rock.

Sixteen cribs, each 32 feet long and 32 feet wide, were sunk continuously from the end of the embankment. These cribs were constructed to a height of about 6 inches above low water of 1864. Pine logs were used from 12 to 20 inches thick, and at least 32 feet long. The logs were fastened together by seven-eights-inch drift-bolts. The pine timbers in superstructure were 6 inches thick, 1 foot wide, and from 12 to 16 feet long. These timbers were fastened together by drift-bolts three-fourths-inch in diameter, and from 12 to 18 inches in length. A slope was given to the lower side and outer end of the superstructure of 16½ horizontal to 12½ vertical. These slopes are covered with oak plank 3 inches thick, and the vertical side is planked with oak 2 inches thick. The top is planked with 3-inch pine.

The total length of breakwater is 871 feet, of which 355 feet are embankment. The top of superstructure is 12¾ feet above low water of 1864.

The cribs and superstructure are filled with rock, most of which was taken from the shore of the lake and from ravines where it had been exposed to frosts and moisture for years without injury.

Material used in work, and cost.

516 pieces pine, 3 inches by 12 inches by 16 feet, top planking	371.52
100 pieces pine, 6 inches by 12 inches by 14 feet, superstructure	126.00
76 pieces pine, 6 inches by 12 inches by 12 feet, superstructure	82.08
2,840 pieces pine, 6 inches by 12 inches by 16 feet, superstructure	4,089.60
336 pine logs, 74,940 feet, B. M., crib-work	1,124.10
516 pieces oak, 2 inches by 12 inches by 12 feet, side planking	309.60
520 pieces oak, 3 inches by 12 inches by 10 feet, side planking	390.00
521 pieces oak, 3 inches by 12 inches by 10½ feet, side planking	410.29
18,945 pounds drift-bolts	537.73
6,762 pounds spikes	201.21
300 pounds 60-penny nails	8.25
8,675.5 cubic yards rock on barges	5,437.85
329.9 cubic yards rock on bank	69.61
73,680 cubic yards gravel put in embankment and foundation	11,715.12
Labor constructing cribs, superstructure, and embankment	5,359.54
Superintendence and contingencies, and care and repair of plant during winter and spring	1,752.72
Total	31,985.23

There remains available for repairs (from allotment for harbor at Lake City, from appropriation for "improving Mississippi River from Saint Paul to Des Moines Rapids," act of July 5, 1884), the sum of $3,014.77.

The work carried out at Lake City gives a good harbor protected from all storms, excepting those coming across the lake. The latter are rarely such as to interfere with the use of the harbor.

It is not thought that any extension of this work will be necessary; and as the available balance of allotment from general appropriation for "improving Mississippi River from Saint Paul to Des Moines Rapids." ($3,014.77), together with such aid as can be given this work in connection with the general improvement, will probably be sufficient to keep the pier in repair during the coming year, no further special appropriation is recommended.

Abstract of appropriations.

By act passed August 2, 1882	$10,000
By allotment act of July 5, 1884*	15,000
By act passed August 5, 1886	10,000
Total	35,000

Money statement.

July 1, 1887, amount available*	$16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16

Y 9.

HARBORS OF REFUGE ON LAKE PEPIN, AT STOCKHOLM, WISC(

A crib-pier 579 feet long, extending into the lake and affordin tection from storms on one side or the other in nearly all conditi wind, was completed in September, 1885. A description and hist the work is given in my annual report for fiscal year ending Ju 1886.

This pier was built by contract, in accordance with plans which as substantial a structure as the available funds permitted. The passed through two winters and springs without injury from s and ice; but during the past April an unprecedented combinati circumstances led to the breaking up of the top of this pier. Th ditions and results are described as follows in a petition present the citizens of Stockholm and Lake City, with a view to securing propriation for repairing the damaged pier :

During the present spring there was a higher stage of water in the lake th ever before known when the ice broke up, reaching the top of the pier, the ic time being two feet thick and as solid as in mid-winter. During the high s water a violent wind-storm moved this great mass of ice with such force as t every thing before it, taking off about 4 feet of the top of the pier. More c was done to private property by ice along the lake than during the previous t five years.

Since the breaking up of the ice in Lake Pepin the stage of has been too great to permit a proper examination of the pie made; but it is thought that about 4 feet have been taken off tl There is now on hand, from appropriation pertaining to this w balance of $5,029.06, which is available for repairs. It is probab amount would be sufficient for rebuilding the pier in accordanc the original plans; but in making repairs it would appear advis so modify plans as to make them conform more nearly to those a for the breakwater built last year at Lake City, which structur more exposed position, passed comparatively safely through th storm that injured the Stockholm pier. At Stockholm the breal was given vertical sides, so that it could also be used as a landin At Lake City the pier was built with sloping side and end, per the ice to slide over rather than push.

The cost of rebuilding the Stockholm pier with sloping sides, cordance with proposed change of plan, can not be estimated wi degree of accuracy until the present condition of the pier is know

* The act of July 5, 1884, appropriated $15,000 for "improving harbor at La Minn., continuing improvement;" but the title was changed on the book Treasury to "Improving Mississippi River from Saint Paul to Des Moines Rap plied to Lake City"—and the $15,000 is now considered as an allotment from eral appropriation, rather than as a separate item. It is therefore considere money statement under heading of "Improving Mississippi River from Saint Des Moines Rapids," and omitted from "amount available July 1, 1887," i *statement.*

is probable that the cost of such work will be $15,000 in excess of the balance now on hand.

The original project for this work contemplated the construction of a breakwater at a cost of $53,498, and there has been appropriated under this project, as modified by change in plan of breakwater, $25,000. It being thought heretofore that the balance on hand would be sufficient to provide for repairs, no further appropriation has been recommended in my annual reports, but it is now necessary to present an estimate for $15,000.

Abstract of appropriations.

By act passed August 2, 1882	$10,000
By act approved July 5, 1884	15,000
Total	25,000

Money statement.

July 1, 1887, amout available	$6,209.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding June 30, 1887	280.33
July 1, 1888, balance available	5,929.06
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

APPENDIX Z.

PRESERVATION OF THE FALLS OF ST. ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF THE CHIPPEWA AND ST. CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI—IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA, AND OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Preservation of the Falls of St. Anthony, Minnesota.
2. Construction of lock and dam on the Mississippi River at Meeker's Island, Minnesota.
3. Mississippi River above the Falls of St. Anthony, Minnesota.
4. Reservoirs at headwaters of the Mississippi River.
5. Chippewa River, including Yellow Banks, Wisconsin.
6. St. Croix River, Wisconsin and Minnesota.
7. Minnesota River, Minnesota.
8. Red River of the North, Minnesota and Dakota.
9. Construction of lock and dam at Goose Rapids, Red River of the North, Minnesota, and Dakota.
10. Surveys for reservoirs at the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers.
11. Missouri River from Sioux City, Iowa, to Fort Benton, Montana.
12. Yellowstone River, Montana and Dakota.

EXAMINATIONS AND SURVEYS.

13. Mississippi River between Saint Paul and St. Anthony's Falls, Minnesota.
14. Minnesota River, with a view to its improvement by locks and dams.
15. Red River of the North, Minnesota, from Moorhead to Fergus Falls.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., July 6, 1888.

SIR: I have the honor to forward herewith reports upon the surveys and works of river improvement in my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Z 1.

PRESERVATION OF THE FALLS OF ST ANTHONY, MINNESOTA.

The history and details of this improvement are given at length in the last annual report. No work was done during the past fiscal year, there being no funds for it.

As there is no navigation at present dependent upon the preservation of the Falls of St. Anthony, and as Congress has made no appropriation for that purpose since 1884, it seems proper to render no estimate under this head for the fiscal year ending June 30, 1890.

Total expended under the last [the present] project, including outstanding liabilities, $405,000.

Total expended under all projects, including outstanding liabilities and the construction of a log-sluice ordered by act of Congress approved March 3, 1879, $615,000.

Money statement.

July 1, 1888, outstanding liabilities	*$86.83
Amount (estimated) required for project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	210,000.00

Z 2.

CONSTRUCTION OF LOCK AND DAM ON MISSISSIPPI RIVER AT MEEKER'S ISLAND, MINNESOTA.

The project for this work is given in the Report of the Chief of Engineers for the fiscal year ending June 30, 1874, and the cost estimated at $922,121.46, the object being to connect with the improvement of the Mississippi River below Saint Paul, so as to secure steam-boat navigation up to the Falls of St. Anthony.

No improvement of the river between Saint Paul and site of the proposed lock and dam has been authorized by Congress.

Congress, by act approved July 23, 1868, made a grant of 200,000 acres of public lands to the State of Minnesota to aid in constructing a lock and dam at this point in accordance with plan and estimate previously submitted.

By act approved March 3, 1873, Congress appropriated:

For construction of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, $25,000: *Provided*, That all rights and claims in and to the land grant made to the State of Minnesota for the above work, by act approved July 23, 1868, shall be fully relinquished to the United States before any of this appropriation is expended.

None of this appropriation has been used, the required relinquishment not having been made.

This appropriation, but little more than 2½ per cent. of the estimate, has been lying unused for fifteen years.

A survey of the Mississippi River between Saint Paul and St. Anthony's Falls, provided for in the river and harbor act of Congress approved August 5, 1886, was made during the season of 1887. The

* Funds are on hand to pay outstanding liabilities.

report of the survey was rendered December 29, 1887, and printed as part of Ex. Doc. No. 158, House of Representatives, Fiftieth Congress, first session. For statistics reference is respectfully made to that report.

Money statement.

July 1, 1887, amount available, subject to conditions in act	$25,000.00
July 1, 1888, balance available, subject to conditions in act	25,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	897,121.46

Z 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE FALLS OF SAINT ANTHONY, MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon the project for the improvement of 252 miles of the river, from Conradi's Shoals to Grand Rapids, the latter the present head of steam-boat navigation; the estimated cost, $54,127.50, is given in the report of February 8, 1875, upon part of the Mississippi transportation routes to the seaboard; plan of improvement to afford 3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing-dams, where necessary.

This same report estimated the cost of improvement of the river between the Falls of Saint Anthony and Saint Cloud at $144,667.50; the improvement of this section to afford 5 feet depth in the channel at low water between the Falls and Saint Cloud by removal of sand, gravel, and bowlder bars and the construction of wing-dams. The sum of $20,000 appropriated by act of Congress approved August 14, 1876, was expended between those places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of $25,000 for improvement of the river above the Falls of Saint Anthony, which was also expended in improving the channel between the Falls and Saint Cloud.

Steam-boat navigation having discontinued between the Falls and Saint Cloud, a distance of 78 miles, the third appropriation made by Congress, that of $15,000 by act approved June 14, 1880, was applied to the stretch, 165 miles in length, of river between Aitken and Grand Rapids, which stretch is included within the distance from the Rapids to Conradi's Shoals, as have been all subsequent appropriations for improving the river above the Falls of Saint Anthony.

No work towards this improvement was done during the past fiscal year, there having been no funds for continuing the work, and for the same reason none has been done since 1884.

Amount expended on the present project to June 30, 1888, including outstanding liabilities, $35,000.

Before work of improvement commenced under the present plan the stream between Aitken and Grand Rapids was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult and sometimes almost impossible for steamers drawing less than 3 feet of water. There is now a general depth in the improved channels of 3 feet at low water, though many masses of gravel

and bowlders yet require to be removed in order to afford sufficient width. Snags form more or less every season, and caving bends furnish leaning trees or sweepers. The movement of ice in the spring also causes deposit, more or less, of bowlders in the channels.

The three completed reservoirs at the headwaters of the Mississippi River above Grand Rapids may be relied upon henceforth to provide sufficient depth for the steam-boats on the river at and above Aitken, but the obstructions, as bowlders, etc., should be removed, as they contract the channel and interfere with the movements of steamers at any stage of water.

The caving of the banks in many places is due to the powerful wheel of the steamer *Andy Gibson*, which carries passengers, freight, and supplies for the lumbermen's camps and settlements, the steamer being too long over all for the narrow widths and sharp bends which occur on this part of the stream.

The sum of $15,000 can be profitably expended during the fiscal year ending June 30, 1890, in continuing the removal of obstructions from the river between Aitken and Grand Rapids, the piece of river to which steam-boat navigation above the Falls of Saint Anthony is at present confined.

There are at present three steamers with barges engaged in freight and passenger transportation between Aitken and Grand Rapids. The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitken and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to $1 per 100 pounds; while in 1883, 1884, 1885, and 1886 the rates reduced to 20 to 40 cents per 100 pounds. The last-named figures obtained in 1886, at which time there were three steam-boats engaged in freighting and carrying passengers between Aitken and Grand Rapids. The country bordering the river north of Aitken is becoming more and more settled, and there is no doubt that the improvement of the river already effected by the United States Government has largely contributed to the increase in settlement.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn. Collections from all sources during the year ending December 31, 1887, $5,290.35; value of merchandise "in transit" trade, $82.415; duties on same, $52,205.49; value of domestic exports, $3,888,138.

Abstract of appropriations made for improving Mississippi River above the Falls of Saint Anthony, Minnesota.

By act approved—		
June 23, 1874		*$25,000.00
August 14, 1876		*20,000.00
June 14, 1880		15,000.00
March 3, 1881		10,000.00
By act passed August 2, 1882		10,000.00
Total		80,000.00
Original estimates for the work between Grand Rapids and Conradi's Shoals		54,127.50
Appropriations by acts—		
June 14, 1880	$15,000.00	
March 3, 1881	10,000.00	
August 2, 1882	10,000.00	
		35,000.00
Remaining to be appropriated		19,127.50

*Made and expended before the adoption of the present project.

Money statement.

July 1, 1887, amount available, including outstanding liabilities ($3.67)..	$3.67
July 1, 1888, outstanding liabilities.....	3.67
Amount appropriated by act of August 11, 1888.....	10,000.00
Amount (estimated) required for completion of existing project, viz, improvement between Grand Rapids and Conradi's Shoals.....	9,127.50
Amount that can be profitably expended in fiscal year ending June 30, 1890	9,127.50

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Comparative statement of the steam-boat business on the Mississippi River between Aitken and Grand Rapids, of the logs run, and of the lumber, shingles, and lath manufactured on the river above the Falls of Saint Anthony, for a period of eight years, 1880–1887, *inclusive.*

Year.	Steam-boats.	Freight carried.	Passengers carried.	Logs run.	Manufactured.		
					Lumber.	Shingles.	Lath.
	Number.	*Pounds.*	*Number.*	*Feet, B. M.*	*Feet, B. M.*	*Number.*	*Number.*
1880*	1	7,874,250	1,000	226,000,000	241,157,989	88,446,125	49,423,100
1881	1	2,200,000	1,540	238,000,000	339,162,197	128,532,050	70,380,750
1882	2	3,026,000	1,764	285,000,000	423,009,250	168,844,000	77,898,000
1883	2	2,800,000	1,100	420,000,000	398,178,995	132,202,450	83,193,825
1884	2	16,000,000	1,346	367,000,000	389,178,995	123,487,300	101,087,360
1885	2	5,000,000	2,400	317,993,000	340,020,000	122,534,000	88,102,000
1886	3	3,000,000	3,500	282,600,000	282,248,700	103,928,000	58,959,000
1887†	3	3,710,400	2,884	‡265,000,000	272,044,907	99,571,050	Unknown.

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time, 1887.
‡ Approximate.

Shippers of freight do not insure their cargoes. The effect of work thus far executed has been to lower the rates on freight between Aitken and Grand Rapids about 50 per cent.

There are no competing routes of transportation, as the steam-boats do about all the carrying trade during the seasons of navigation. There were during the season of 1887 three steamers which competed with each other.

Rates of freight from Aitken to Grand Rapids, from 1880, *when work of improvement began, to* 1887, *inclusive.*

Years.	Rate per 100 pounds.	Years.	Rate per 100 pounds.
1880	$0.75–$1.00	1884	$0.40–$0.50
1881	.75– 1.00	1885	.25– .40
1882	.75– 1.00	1886	.20– .40
1883	.50– .75	1887	.25– .25

The foregoing table shows the benefits to the community in the matter of the saving of expenses in getting their supplies of all kinds to and from market.

Z 4.

RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi

River below the dams. Reduction of heights of floods in localities immediately below the dams expected to obtain to some extent, but control of extended floods or freshets not expected.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various Annual Reports of the Chief of Engineers.

The résumé of the subject is given in the Report of the Board of Engineers printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted, and further examinations in 1880, the first cost of constructing forty-one reservoir dams in Minnesota and Wisconsin was placed at $1,809,083, exclusive of that of land damages, which could not be given in advance. (See page 1781, Appendix W to Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnibigoshish, made by act of Congress approved June 14, that year. For the reasons given in the annual report for 1886, the work of construction commenced and has been continued in Minnesota.

Four reservoirs have been completed; the last, on Pine River at the outlet of Cross Lake, having been completed in 1886, though the greater part of the main dam was finished in 1885.

Congress, by act approved August 5, 1886, appropriated as follows:

For continuing operations upon the reservoirs at the headwaters of the Mississippi River, $37,500: *Provided*, That, in the opinion of the Chief of Engineers, the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation.

The subject was referred to the Board of Engineers mentioned above. The Board recommended the raising the Pokegama Reservoir Dam 2 feet; the building a dam in the Sandy Lake District, if elaborate surveys should prove such to be feasible; the necessary legislation to provide for operating dams; and gaugings of volume of discharge at or near Saint Paul during the annual operations of the reservoirs.

The survey of Sandy Lake and River was accordingly undertaken, as were some needed examinations at the Pokegama Reservoir, upon which to base plans and estimates.

The past winter was very severe and communication with the dams difficult. The streams and swamps between Aitken and Pokegama Falls were, in addition, swollen during a part of the spring following, prolonging the time during which it was difficult to communicate with the dams. Plans, however, for the work necessary to increase the lift of the Pokegama Reservoir were made and submitted to the Department June 12, 1888.

The interference with the free operations of the dams in the interest of navigation, and the consequent waste of water, resulting from conflicting operations of lumbermen, and the necessity for legislation in the matter, have been detailed in preceding annual reports.

During the past fiscal year the dams and appurtenances, and United States engineer property stored at the dams, have been cared for and protected as usual. The foot of the log-sluice at the Pine River Dam was protected by timber cribs; the work being done by hired labor.

The navigation season of 1887 was a very dry one in this part of the country, all the streams being at a remarkably low stage. The accumulated water in the four reservoirs was released during the season of 1887 with good effect, as the following account of their performance shows.

The drainage areas tributary to the four reservoirs constitute about 11 per cent. of the whole drainage basin tributary to the Mississippi River at Saint Paul at a point below the mouth of the Minnesota River, and 20 per cent. of the basin tributary to the river at St. Anthony's Falls. Without taking into consideration the liberal discharge of water prior to August, the continuous discharge of the reservoirs for eighty-six days in August, September, October, and November, when the Mississippi needed water, may be briefly stated as follows:

For fifty-eight days the average volume of water discharged from the four reservoirs was not less than 36 per cent. of the entire volume of water flowing past Saint Paul at a point below the mouth of the Minnesota River; and for twenty-eight days, continuously, the percentage was 42. At the Falls of St. Anthony the volume of water furnished by the reservoirs was, for fifty-eight days, 40 per cent. of the entire volume of discharge of the river, and for twenty-eight days 47 per cent.

The benefit of the reservoir volume extended over some 425 miles of river below Grand Rapids, the Rapids being 388 miles, by river, above Saint Paul. Of the 425 miles, 200 are navigated by steamers.

The increase in channel depth at Saint Paul due to release of the stored-up water undoubtedly averaged for the eighty-six days 1 foot to 1½ feet.

The completed dams and their appurtenances must be guarded and maintained. The annual cost of guarding, maintaining, and operating is placed at $12,000, which sum is estimated as necessary for the fiscal year ending June 30, 1890.

The balance of funds available July 1, 1888, from the appropriation of 1886 will be applied to care of the completed reservoirs, to increasing the lift of the Pokegama Reservoir 2 feet, and to further investigation of Sandy Lake with a view to establishing a reservoir at that point. Should the result of the investigation warrant, reservoir dams at that lake will probably be commenced during the coming fiscal year.

Total expended upon this improvement, including examinations at proposed dam-sites, hydrological observations, land damages, and amounts set aside as awards to Indians, to June 30, 1888, is $596,800.27

Expended during the fiscal year ending June 30, 1888, $12,583.09.

For commerce benefited and to be benefited by the reservoir system reference must be made to the commercial statistics of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers.

Abstract of appropriations.

By act approved June 14, 1880	$75,000.00
By act approved March 3, 1881	150,000.00
By act passed August 2, 1882	300,000.00
By act approved July 5, 1884	60,000.00
By act approved August 5, 1886	37,500.00
Total	622,500.00
Allotment per letter from office Chief of Engineers, November 9, 1881	1,572.15
Allotment per letter from office Chief of Engineers, January 20, 1882	176.00
Allotment per letter from office Chief of Engineers, May 11, 1888	8.60
Allotment per letter from office Chief of Engineers, January 18, 1888	643.85
Awards to Indians for damages in connection with the building of Leech Lake and Lake Winnibigoshish dams, letter from office of Chief of Engineers, August 7, 1885	15,996.90
Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam-sites, letter from office Chief of Engineers, May 27, 1881	7,500.00

Expended by officer in charge in connection with the building of four reservoir dams to June 30, 1888, including outstanding liabilities...	$570,902.77
Total alloted and expended to June 30, 1888, including outstanding liabilities	596,800.27
Estimated cost of the system (omitting that of land, etc., damages)...	1,809,083.50
Amounts appropriated	622,500.00
Remaining to be appropriated	1,186,583.50

Money statement.

July 1, 1887, amount available		$38,282.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,617.16	
July 1, 1888, outstanding liabilities	965.93	
		12,583.09
July 1, 1888, balance available		25,699.73
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		37,699.73
Amount (estimated) required for completion of existing project		1,174,583.50
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Z 5.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

This improvement consists in the construction of dams and jetties to confine the low-water volume to a practicable channel, and in revetment of caving bends between Eau Claire and the mouth of the river, a distance of 57 miles.

The general plan of improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less as to location and extent of dams, jetties, etc.

The examination of the river upon which this improvement is based was made in 1874, and the results thereof reported January 30, 1875. (See pages 375–380, Part I, Annual Report of Chief of Engineers, 1875.) The estimated cost of improvement from Eau Claire to the mouth of the river, based upon that report, summed up $139,892.50, of which $64,102.50 was estimated as the cost of protecting the Yellow Banks. The protection of these banks has since been made a separate work.

The revised estimate (see page 1440, Appendix X, Annual Report of Chief of Engineers for 1883) for the cost of this work brought it up to $132,476.35, including all the expenditures from the commencement of the improvement. The estimate, as further revised (see Appendix A A to Annual Report for year ending June 30, 1887), showed that $55,522.96 would be required for completing the work, and this was presented in that report as a new estimate, bringing the cost of complete improvement, including all expenditures since 1876, up to $172,272.96.

During the past fiscal year the training-dam at Eau Claire was leveled off and repaired, and the dam at Dark Slough also repaired and extended 95 feet. The brush and stone dams at Five Mile Bluff, Battle

Island, and Dead Lake Cut-off, and the jetties at the mouth of the river also received repairs, and the shore revetment at the head of the east jetty was extended 150 feet.

The work was performed by day labor.

Wherever works have been constructed by the Government for the improvement of the river the navigation has been benefited, a low-water depth of 3 to 4 feet being maintained where before the works were undertaken the depth seldom exceeded 18 inches. The work for improvement has been principally confined to the extent of river between the mouth and Durand, 16½ miles, and to the vicinity of Eau Claire.

The jetties at the mouth of the river have been of incalculable benefit to raft and steamboat navigation in securing a stable channel of sufficient depth where before improvement commenced there was a broad bar intersected by shallow, shifting channels, passable with great difficulty at times of low water by rafts and steamers. A number of shoals still need improvement, and some of the dams and revetments are in need of repairs, or rather of full completion.

The injurious effect upon the channel from the operation of private sluicing dams on the river and its tributaries has been noticed in preceding reports.

Expended during the fiscal year ending June 30, 1888, including outstanding liabilities, $4,214.76.

Total expended from commencement of operations to June 30, 1888, including outstanding liabilities, $115,712.72. This includes work, material, necessary examinations, superintendence and contingencies, and repairs, which for eleven years have been considerable. on account of the shifting bed of the stream.

Number of linear feet of dams, jetties, and revetments constructed and kept in repair, 1877 (*when work was begun*) *to* 1888.

Description.	Locality.	Linear feet.
East jetty, 2,110 linear feet	Mouth of river..	*6,219
West jetty, 4,013 linear feet	....do	
Shore revetments	...do	654
Dam, including shore protection connections	Little Missouri Chute	383
Dams, including shore protection connections	Flower-Pot Bar.	2,470
Shore protection	Three Mile Prairie	1,335
Dam, including shore protection connections	Dark Slough	354
Do	Wacouta Island	545
Do	Battle Island	1,182
Do	Jack Staff Island	410
Do	Plum Island	525
Do	Dead Lake Cut-off	475
Jetties, including shore protection connections	Durand	1,200
Dam, including shore protection connections	Eau Claire	810
Upper dam, including shore protection connections	Five Mile Bluff	925
Lower dam, shore protection only completed	....do	75
Dam, shore protection only completed	Twin Islands	75
Total		17,637

* Ninety-six feet of this is shore connection.

With the balance from appropriations available July 1, 1888, existing dams, jetties, and revetments will be extended and repaired so far as the funds will admit.

The original estimate, based upon the examination in 1874, included, omitting the Yellow Banks, improvement of about twenty-eight localities, mostly sand and gravel bars, between Eau Claire and the mouth

of the river. Many of the unimproved bars vary in size and shift in position, depending upon floods and following stages of water. The banks, easily eroded, also contribute sand to the river after every high water, rendering more or less revetment necessary. *Consequently, an estimate of cost made in* 1875 *would differ from one made in* 1883, *and both from one made to day.* Insufficiency in appropriations also adds to the ultimate cost, as partly finished work must be maintained.

In 1882 occurred a dangerous diversion of the river into Dead Lake, making a cut-off that threatened destruction of the channel for many miles below it. It was necessary to close this by a strong dam of brush, stone, and piles. Under the appropriation of August 5, 1886, which provided for continuing improvement of the river from the Dalles Dam to its mouth, thus increasing the amount of work to be done, a dam 810 feet in length was built at Eau Claire. Under appropriations to date, thirteen localities have been improved, and the works maintained and repaired. The item of repairs is considerable, as some of the dams were constructed as early as 1877 and 1878.

The following-named localities require improvement:

Locality.	Nature of improvement.	Linear feet (approximately).
Between the jetties and upper end of Flower Pot Bar	Shore protection	2,000
	Dam	2,500
At Five Mile Bluff Bar	Dam and shore protection	1,600
Between Seven Mile Bluff and Plum Island	Dams	1,800
Bar at Ella, between Plum Island and foot of Dead Lake Cut-off Dam.	Dams	800
Eau Galle Bars	Dams	1,200
Bear Creek Bars	Dams	1,000
Dark Slough	Dams	150
Total		11,050

11,050 linear feet, at an average cost of $5 per linear foot	$55,250.00
Add contingencies, 10 per cent	5,525.00
	60,775.00
Deducting balance of appropriation available July 1, 1888	1,037.28
The cost of completing the improvement is about	59,737.72

The sum of $25,000 can be profitably expended during the fiscal year ending June 30, 1890, in furtherance of the plan of improvement.

Since the branch of the Chicago, Milwaukee and Saint Paul Railway was built, in 1882, from Wabasha, on the Mississippi River, to Eau Claire, the branch being close to and generally parallel with the Chippewa, the freight and passenger traffic of the latter have declined. The rafting of manufactured lumber, lath, shingles, and pickets varies in different years, the rafts moving down the Chippewa and between the jetties into the Mississippi. In 1881 the lumber rafted was reported as 342,887,000 feet B. M.; in 1885, 374,138,443 feet; in 1886, 207,205,672 feet; in 1887, 186,826,521 feet. The saw-logs, from 300,000,000 to 600,000,000 feet B. M., which are annually run down the Chippewa, are made up into rafts at Beef Slough for points on the Mississippi River.

The reduction in the cost of running lumber from Eau Claire to the Mississippi River, due to the improvement of the river by the United States, can be arrived at by comparing the contract rates paid by the Daniel Shaw Lumber Company. In 1877, the year when the improvement was commenced, they paid 53½ cents per thousand feet, B. M.; *in 1886 and 1887* they contracted for 37 cents.

Attention is invited to the comparative tables of statistics herewith.

Abstract of appropriations made for improving Chippewa River, Wisconsin.

By act approved—	
August 14, 1876	$10,000
June 8, 1878	10,000
March 3, 1879	8,000
June 14, 1880	10,000
March 3, 1881	10,000
By act passed August 2, 1882	35,000
By act approved—	
July 5, 1884	15,000
August 5, 1886	18,750
Total	116,750

AT YELLOW BANKS.

The object of this work is to prevent erosion of the high sand-banks or bluffs on the Chippewa River below Eau Claire, and thereby relieve the channels of this river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks.

The original estimate of the cost of this work was $64,102.50, as given in the report upon the cost of improving the Chippewa River, January 30, 1875, and this is the estimate upon which, it is presumed, the appropriation for the work, viz, that of $30,000, by act passed August 2, 1882, was made. The estimate as revised in 1883 was placed at $96,000. (See Annual Report for that year.)

The work of protection commenced in 1883, under the appropriation by act of Congress passed August 9, 1882. The plan for protection adopted in 1883 consisted in a revetment of piling and fascines. The latter should be crowned with rock. The condition of the work at the close of 1883 was as follows:

At Waubeek Bank, 2,939 feet long; protection completed.

At Rumsey's Bank, 4,500 feet long, piles all driven and 1,850 linear feet of protection completed.

At Mary Dean Bank, 6,900 feet long, piles have been driven for 625 linear feet, and 139 feet of the protection completed.

The work was all done by day labor.

Two banks near Eau Claire, total length of 8,300 feet, have not as yet had any work done upon them. Total upon which no work has been done, 15,886 linear feet.

With the small balance of funds ($218) remaining from the appropriation of 1882 and available at the commencement of the fiscal year, the revetment received some small repairs by hired labor during the past season. The work, however, is still unfinished, and a crowning of rock upon the completed portion of it is very much needed, as stated in preceding reports.

The sum of $30,000 can be profitably expended during the fiscal year ending June 30, 1890, on the protection of Waubeek, Rumsey's, and Mary Dean banks.

This work is in the collection district of Milwaukee, Wis. The collections for this district for the year ending December 31, 1887, amounted to $326,869.60.

Revised estimate of cost of improvement	$96,000
Appropriated by act passed August 2, 1882	30,000
Remaining to be appropriated	66,000
Total amount expended to June 30, 1888, including outstanding liabilities	30,000

For statistics of the trade and commerce to be benefited by this improvement, reference is made to the annual report upon improvement of the Chippewa River, Wisconsin.

Money statement.

July 1, 1887, amount available		$5,47
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,406.21	
July 1, 1888, outstanding liabilities	26.55	
		4,43
July 1, 1888, balance available		1,03
Amount appropriated by act of August 11, 1888		10,00
Amount available for fiscal year ending June 30, 1889		11,03
Amount (estimated) required for completion of existing project		111,52
Amount that can be profitably expended in fiscal year ending June 30, 1890		55,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Commerce of the Chippewa River, Wisconsin, in 1877, being the year following the appropriation (August 14, 1876) for work of improvement.

Lumber	feet, B. M.	160,000
Lath and pickets	number	30,000
Shingles	do	40,000

The number of steam-boats plying on the Chippewa River in 1877 or the amo of business done by them can not be stated exactly. It is said, however, that business was about the same as in 1881 and 1882. The latter will be found in comparative statement following.

Present (1887) commerce of the Chippewa River.

Lumber	feet, B. M.	186,82
Lath	number	64,72
Shingles	do	130,51
Pickets	do	3,02
Logs (Beef Slough)	feet, B. M.	404,30

But one steam-boat plied regularly on the river during the season of 1887. boat, the *Phil. Scheckel*, ran from the mouth to Dunnville, about half-way betw the mouth and Eau Claire, to assist the Knapp, Stout & Company's rafts in floa down the river. Her passengers and freight were confined almost entirely to company's rafting business.

Comparative statement of lumber, logs, etc., for seven years.

Year.	Lumber.	Lath.	Shingles.	Pickets.	Beef S log
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Feet,*
1887	186,826,521	64,725,580	130,516,200	3,023,235	404,3
1886	207,205,672	77,729,630	158,645,750	1,934,340	465,0
1885	374,138,443	95,992,900	195,880,220	75,000,000	600,0
1884	298,344,591	88,905,520	160,133,000	1,840,278	534,6
1883	269,094,203	82,643,500	129,754,000	1,497,948	450,0
1882	375,000,000	66,000,000	150,000,000	2,200,000	350,0
1881	342,887,000	64,787,600	121,437,000	1,880,900	300,0

Comparative statement of freight and passengers for seven years.

Year.	Steam-boats.	Freight carried.	Passengers carried.	Year.	Steam-boats.	Freight carried.	Passe carr
	Number.	*Pounds.*	*Number.*		*Number.*	*Pounds.*	*Num*
1887	1	600,000	1,400	1883	3	3,184,000	
1886	1	Not stated.	4,700	1882	3	2,640,000	
1885	1	690,000	4,728	1881	3	3,932,000	
1884	2	1,500,000	5,500				

Following are extracts from a letter of Mr. A. O. Powell, assistant engineer, this office, dated Eau Claire, Wis., December 15, 1886:

"In 1882 the rates by river from Read's Landing to Eau Claire were—

First-class freight	per 100 pounds	$0.65
Second-class freight	do	.45
Third-class freight	do	.25
First-class passenger fare		2.50
Second-class passenger fare		2.00
Freight on oar stems	each	.80

"By rail via the Chippewa Valley Division of the Chicago, Milwaukee and Saint Paul Railway, completed in July, 1882:

First-class freight	per 100 pounds	$0.40
Second-class freight	do	.34
Third-class freight	do	.29
Fourth-class freight	do	.24
First-class passenger fare (since October 15, 1886, $1.40)		1.85
Second-class passenger fare		1.40
Freight on oar stems (approximate)	each	.40

"The railroad carries the oar stems by weight.

"It has not been the practice to insure freight or lumber in transit.

* * * * * * *

"The reduction in cost of running lumber from Eau Claire to the Mississippi River, due to United States improvements, can be arrived at by inspecting the contract rates paid by the Daniel Shaw Lumber Company. In 1887 they paid 53½ cents per thousand feet, B. M.; in 1886 they contracted for 37 cents.

"Lumbermen claim that they could not have run lumber this year, during the extreme low water, had it not been for the wing-dams and jetties.

"The improvements have had no effect on freight rates by rail for general merchandise.

"The prospective advantages of the completion of the improvement will be confined to the lumbering interests."

Z 6.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The original project for the improvement of this river, adopted in 1878, was based upon the results of a survey made in 1874, when the St. Croix was at a high stage of water and but comparatively few bars, etc., to be seen, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand-bars between Taylor's Falls and Prescott, and contraction of the low-water channel between Taylor's Falls and Stillwater into one of nearly uniform width by means of brush and stone jetties and dams of the same material to close island chutes and secondary channels. Estimated cost, $21,758.

The present project, adopted in 1880 and modified in 1882, is based upon the results of a low-water survey made in 1879, the resulting estimate of cost (see page 1444, Appendix X, Annual Report, 1883) being $83,450. This provided for removal of obstructions, as did the original plan, excepting that it considered more work for the approaches to the "canal" between Four Mile Island and the foot of the St. Croix Boom than did the original plan.

The first appropriation for the improvement of the St. Croix was $10,000, made by act of Congress approved June 18, 1878.

At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom-piers, and the bends by leaning trees. The low-water channel had in many places

but little more than 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions.

Under this appropriation some of the worst obstructions were removed between Taylor's Falls and Stillwater.

Another appropriation of $8,000, by act approved March 3, 1879, was expended in the same manner, and in addition the stream was thoroughly surveyed from Taylor's Falls to Prescott, the results of which were reported January 26, 1880 (see pages 1661–1667, Appendix U, Annual Report of the Chief of Engineers, 1880).

Upon the results and maps of this survey is based the present plan of improvement.

The work performed in 1878–'79 lessened the difficulties to navigation within the limits worked over.

Under the appropriation of $10,000, by act approved June 14, 1880, work began under the present project, which consists in the construction of dams and jetties to confine the low-water volume to a practicable channel and in removal of snags, bowlders, cribs, and other obstructions from the channels between Taylor's Falls and Prescott.

The work was all performed by hired labor. For full description and details see last annual report.

Owing to lack of funds no work for improvement has been done during the past fiscal year, the small balance having been required for care and protection of the plant pertaining to the work and for general contingencies.

Total expended under present project to June 30, 1888, including outstanding liabilities, $64,362.32.

Total expended on original and present projects since commencement of work of improvement, including outstanding liabilities, $82,362.32.

The result of the work to date is a least depth upon the bars above Stillwater, where improvements have been made, of 3 feet at low water and below Stillwater of 4 to 5 feet. Generally, it may be said of the work that at many points navigation has been rendered permanent where formerly it was uncertain, and that in other places it has been made practicable where before improvement it was impossible. There are some bars yet that require improvement above Stillwater, and some of the existing works need small repairs. The Hudson Wall should be extended and the channel at this point should receive additional dredging. The training-dam at Catfish Bar should be leveled off and extended 150 feet, and a short jetty with good shore connection should be constructed on the Wisconsin side opposite, as explained and illustrated in the last annual report.

As showing the amount of commerce benefited and to be benefited by the improvement, reference is made to the accompanying statistics of the St. Croix River.

The largest steamers plying the Mississippi River between Saint Paul and Saint Louis ascend the St. Croix to Stillwater, the head of an immense steam-boat and lumber-rafting business, which is dependent upon these improved channels. Smaller steamers run between Stillwater and Taylor's Falls, carrying passengers, agricultural implements, grain, etc.; from forty to sixty raft-boats navigate the stream below Stillwater.

Before the completion of the railroad to Taylor's Falls, Minn., the towns along the St. Croix River could get their supplies to and from market only by water and wagon transportation, and even since the completion of the railroad the steam-boats have carried the larger portion of the freight, and for some time to come they will do the same

during seasons of navigation, for the reason that they (the steam-boats) can make all the landings along the river, whereas the railroads will strike only certain towns, leaving others along the river to depend upon steam-boats.

The advantages and benefits to the people of the Lower St. Croix Valley due to the improvements already effected are evident from the lowering of freight rates, which, it is stated, have been reduced at least 50 per cent. since the improvement of the stream commenced. On wheat alone the saving in freight is said to have been considerable.

The work of improvement on the St. Croix has also resulted in lowering rates of marine insurance as well as in causing stronger competition by increasing the facilities for Mississippi River boats ascending to Stillwater and thus competing with boats that plied the St. Croix River exclusively. It has also enabled steamers to compete with the railroad to Taylor's Falls, the head of navigation.

The sum of 18,950 can be profitably expended during the fiscal year ending June 30, 1890, in furtherance of the existing project, principally at Hudson and Catfish bars, and in repairs to and extension of the revetment at Kelly's Island above Stillwater, where a diversion of the channel has been threatened for several years past.

Portions of the river-bed between Stillwater and Taylor's Falls are much obstructed at times by log-booms, which have been noticed in previous reports.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenues collected during the year ending December 31, 1887, amounted to $5,290.35; value of domestic exports for 1887, $3,888,138; value of merchandise "in transit trade," $82,415; duties on same, $52,205.49.

Abstract of appropriations made for improving St. Croix River, Wisconsin and Minnesota.

By act approved June 18, 1878	*$10,000
By act approved March 3, 1879	*8,000
By act approved June 14, 1880	10,000
By act approved March 3, 1881	8,000
By act passed August 2, 1882	30,000
By act approved July 5, 1884	9,000
By act approved August 5, 1886	7,500
Total	82,500

Money statement.

July 1, 1887, amount available		$458.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$312.49	
July 1, 1888, outstanding liabilities	8.32	
		320.81
July 1, 1888, balance available		137.68
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,137.68
Amount (estimated) required for completion of existing project		8,950.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,950.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

*Appropriated before adoption of present project.

COMMERCIAL STATISTICS.

Comparative statement of steam-boats and barges, freight, passengers, towing, rafting, logs, lumber, etc., manufactured on the Saint Croix River, Wisconsin and Minnesota, for a period of ten years, 1878–'87.

STEAM-BOATS AND BARGES.

Year.	In freight and passenger business.		In towing and rafting business.		Year.	In freight and passenger business.		In towing and rafting business.	
	Steamboats.	Barges.	Steamboats.	Barges.		Steamboats.	Barges.	Steamboats.	Barges.
1878*	3	.....	8	.....	1883	3	25	51	.....
1879	3	.....	12	.....	1884	3	25	30	.....
1880	3	.....	29	.....	1885	4	33	50	.....
1881	2	.....	40	.....	1886	6	38	49	.....
1882	3	24	77	.....	1887†	3	40	58	.....

*Amount of commerce and navigation when work of improvement began.
†Amount of commerce and navigation at present time, 1887.

FREIGHT, PASSENGERS, AND LOGS.

Year.	Freight carried, to include merchandise, lumber, wood, etc.	Passengers carried.	Logs towed out of Saint Croix River (estimated).	Logs passed through Saint Croix Boom.	Lumber towed out of Saint Croix River.
	Pounds.	*Number.*	*Feet B. M.*	*Feet B. M.*	*Feet B. M.*
1878[1]	32, 000, 000	15, 000	70, 000, 000	160, 000, 000	Not given.
1879	47, 786, 995	9, 244	117, 000, 000	202, 000, 000	Do.
1880	([2])	([2])	200, 000, 000	207, 100, 000	Do.
1881	[3]35, 000, 000	11, 015	185, 000, 000	233, 000, 000	Do.
1882	[4]60, 000, 000	10, 300	130, 000, 000	276, 000, 000	Do.
1883	[5]63, 000, 000	2, 800	108, 000, 000	270, 000, 000	Do.
1884	[6]80, 000, 000	4, 000	175, 000, 000	275, 000, 000	Do.
1885	[7]85, 000, 000	10, 647	150, 000, 000	231, 000, 000	Do.
1886	[8]180, 000, 000	12, 756	115, 700, 000	198, 500, 000	Do.
1887[9]	[10]57, 009, 320	9, 872	175, 000, 000	300, 000, 000	100, 000, 000

[1] Amount of commerce and navigation when work of improvement began.
[2] Estimated same as 1879.
[3] About 12,000,000 pounds lumber and wood.
[4] About 48,000,000 pounds lumber and wood.
[5] About 53,000,000 pounds lumber and wood.
[6] About 70,000,000 pounds lumber and wood.
[7] About 73,000,000 pounds lumber and wood.
[8] About 85,000,000 pounds lumber and wood.
[9] Amount of commerce and navigation at present time, 1887.
[10] About 56,000,000 pounds lumber and wood.

LUMBER, ETC., MANUFACTURED.

Year.	Lumber.	Shingles.	Laths.	Pickets.
	Feet B. M.	*Number.*	*Number.*	*Number.*
1878*	Not stated..	Not stated..	Not stated..	Not stated.
1879	83, 727, 820	40, 238, 000	27, 600, 000	Do.
1880	132, 475, 078	54, 052, 500	37, 845, 000	Do.
1881	135, 000, 000	70, 000, 000	40, 000, 000	362, 000
1882	116, 000, 000	62, 000, 000	32, 000, 000	200, 000, 000
1883	167, 000, 000	80, 000, 000	45, 000, 000	615, 000
1884	125, 000, 000	25, 000, 000	25, 000, 000	615, 000
1885	200, 000, 000	65, 000, 000	30, 000, 000	11, 000, 000
1886	75, 000, 000	1, 400, 000	600, 000	Not stated.
1887†	150, 000, 000	55, 000, 000	32, 000, 000	9, 000, 000

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time, 1887.

Z 7.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

For want of funds no work for improvement was done during the past fiscal year, nor has any been done since February, 1879, the last appropriation for the improvement having been that made by act approved June 18, 1878. For the history of this improvement, see last Annual Report.

As Congress has not made any appropriation since 1878 for the improvement of the Minnesota, it seems proper to not submit any estimate for the year ending June 30, 1890.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River with a view to its improvement by locks and dams. The survey, extending from the mouth of the river to Mankato, was made during the past season, and a report thereon, with maps, rendered January 16, 1888. This report, printed in Ex. Doc. No. 158, House of Representatives, Fiftieth Congress, first session, is respectfully referred to as containing the most reliable statistics of the present and prospective commerce of the Minnesota River that could be obtained.

Abstract of appropriations made for the improvement of the Minnesota River.

By act approved—	
March 3, 1867	$37,500
July 11, 1870	10,000
March 3, 1871	10,000
June 10, 1872	10,000
March 3, 1873	10,000
June 23, 1874	*10,000
March 3, 1875	10,000
August 14, 1876	10,000
June 18, 1878	10,000
Total	117,500

Total expended under last adopted project for improvement of this stream, $29,967.

Total expended under all projects for same, $117,467, including in this amount the sum of $10,000 expended for survey in 1874.

Money statement.

July 1, 1887, amount available, including outstanding liabilities ($9)	†$42.00
July 1, 1888, outstanding liabilities	9.00
July 1, 1888, balance available	33.00
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,033.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	693,868.63

* Used in making survey of river.

† Deposited to credit of Treasurer of the United States November 11, 1885.

Z 8.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND DAK(

The present, which is also the original, project for the improveme this river from Breckenridge to the northern boundary line, adopte 1877 and amended as to estimate of cost in 1883, consists in the rem of snags, leaning trees, and bowlders, and in dredging channels thro the bars.

The estimated cost of this improvement, omitting the item of impr ment of Goose Rapids, as based upon the reports of 1874, 1875, and (see pages 730–732, Report of Chief of Engineers, 1878), was $145,31(which estimate, as revised, and for the reasons stated in Appendix of the Annual Report of 1883, was increased to $179,310.18.

The river and harbor act of Congress approved August 5, 1 making the money theretofore appropriated for locks and dams at G Rapids available for dredging, removal of snags and bowlders, and struction of wing-dams, necessarily included in that mode of impr ment Goose Rapids, which were originally intended to be improved means of locks. For this reason, as well as for others given in the Annual Report, a new estimate of cost of completing the work bec necessary. The cost was placed at $79,598.37 (see Appendix A the Annual Report of the Chief of Engineers for 1887, pages 1714, 17

The dredge-boats were operated during the year on the low miles of Goose Rapids, thence to a point 62 miles north, by river, f Grand Forks.

The excavated material was utilized, as in former years, in form training-dams to confine and direct the water at low stages, and als as far as possible leave the area of cross-section of the stream after cavation what it was before excavation, and also so placed as to red wherever necessary, the velocity of the stream. In general, the w has been so carried on that, while increasing the depths at crossi the pools above and below the bars have not been lowered. The terial, a tough, leathery clay, is not liable to be rapidly washed a and the best disposition that could be made of it was to use it for d To raise the material to the top of the bank through heights of 3 45 feet would have been expensive without securing much if any vantage, as floods frequently cover the banks and approaches to river.

Summary of work done during the year ending June 30, 1888.

Cubic yards of material dredged	2
Length of wing and training dams built ... feet	
Length of channel cuts ... do.	1
Total of miles of river worked over	
Number of trees and snags removed	
Cubic yards of bowlders removed	
Average cost of dredging and dumping, per cubic yard	$
Average cost of removal of bowlders, per cubic yard	
Average cost of removing trees and snags, per tree or snag	

The total (as revised to date) work done upon this stream since first appropriation for its improvement was made by Congress in 1 and extending from Fort Abercrombie to the point where dred ceased during the past fiscal year, a distance of 290 miles by rive as follows:

Cubic yards of material dredged	46
Number of snags removed	

nber of overhanging trees removed	8,705
bic yards of bowlders removed	3-2
mber of stumps removed	198
mber of piles removed	23
mber of drift-piles removed	8
arge removed	1
otal linear feet of channel excavated	82,172
otal linear feet of wing and training dams constructed	119,242

Mr. Rufus Davenport, assistant engineer upon this improvement for he past five seasons, is deserving of great credit for faithfulness and eal in carrying out the work intrusted to him.

All the work for improvement of this stream has been performed by ired labor.

GENERAL CONDITION OF THE WORK.

The 3-foot dredged channels from Moorhead to a point 80 miles north, eraging 60 feet in width at low water, and the 4-foot dredged chan- ls from Grand Forks to a point 62 miles north (distances by river), eraging 70 feet in width, are in good condition, and no difficulty is erienced over those improved portions of the stream by boats loaded those depths at ordinarily low stage of water, and 3 feet can be car- l over the improved portions of the rapids and of the river between g Point and Grand Forks. The removal of snags and trees between rhead (opposite Fargo) and Abercrombie improved that portion of stream for navigation during high and medium stages of water.

ie river is subject to land-slides, several of which have occurred in the past three years at Goose Rapids and near Frog Point. e slides can never be anticipated, form obstructions when they oc- and have to be removed in whole or in part, thereby increasing the int and cost of the improvement.

nerally, since the first bars were dredged in 1879, the carrying of 1 in barges has been greatly facilitated. Before the dredging com- ced in 1879 there were but 1½ feet of water (ruling depth) upon bars een Moorhead and Goose Rapids and 2 feet on the bars below id Forks at ordinarily low water; and before the removal of snags leaning trees between Moorhead and Abercrombie navigation over portion of the stream was at all times difficult.

ie comparative statement of freight carried during the calendar s 1879–'87, appended, shows considerable fluctuation, being great- n 1882 and least in 1886. The decrease for 1886 must be attributed ly to the extremely low water of that year, the stage of water at id Forks during the fall averaging 1.5 feet lower than had ever re been recorded, and partly to the increased facilities for shipment ailroad.

sistant Engineer R. Davenport reports as follows:

movements of steam-boats on the Red River during the season of 1887 was also ially affected by the continued low-water stage. The precipitation in the Red Valley during the year was about up to the average. The entire country had, rer, become so dry from the drought of the previous year that an unusually small rtion reached the river.

the upper river, from Goose Rapids south, the boats were operated with fair s until about the 1st of July; after that date the stage of water was too low for ation.

the lower river, from Goose Rapids north, steam-boats continued running dur- e entire season, though after the 1st of July it was necessary to load very light s over the undredged bars.

ge quantities of wheat remained in the elevators at the close of the season.

COMMERCIAL STATISTICS RED RIVER OF THE NORTH, BETWEEN BRECKENRIDGE AND THE BOUNDARY LINE, SEASON OF 1887.

There were two steam-boat lines operating on the river during the season of 1887: The Grandin Line, one steam-boat and a fleet of barges, operating between Fargo, Dak., and the head of Goose Rapids; and the Red River Transportation Company, two steam-boats and a barge fleet; one steam-boat, the *Pluck*, running north and south from Moorhead, and the other, *H. W. Alsop*, running north and south from Grand Forks, Dak.

The following is a statement of the amount of freight moved by the different lines:

GRANDIN LINE.

	Pounds.
Steamer *Grandin:*	
From points north to Fargo—	
Wheat	6,980,580

RED RIVER TRANSPORTATION COMPANY.

Steamer *Pluck:*	
From points south to Moorhead—	
Wheat	4,640,000
From Moorhead to points south—	
Merchandise	30,000
Steamer *H. W. Alsop:*	
From Grand Forks to points north and south—	
Merchandise	182,880
Lumber	2,240,110
To Grand Forks from points north and south—	
Wheat	9,705,320
Wood	1,150,000
Total	24,928,890

RECAPITULATION.

Grandin line, south of Goose Rapids	6,980,580
Red River Transportation Company, south of Goose Rapids	4,670,000
Red River Transportation Company, north of Goose Rapids	13,278,310
Total	24,928,890

Although but few steamers, comparatively, navigate the Red River at present, the fact of an improved river being available for an unlimited number of steamers and barges whenever railroad rates become insupportable, operates to the advantage of the farming community.

Expended upon this improvement during the fiscal year ending June 30, 1888, including outstanding liabilities, $12,330.48.

Expended upon the improvement from commencement of work in 1877 to June 30, 1888, including outstanding liabilities, $160,212.52.

It is proposed to apply the balance of appropriation remaining in furtherance of the present project of improvement.

The sum of $40,000 can be profitably expended during the fiscal year ending June 30, 1890, in continuing dredging operations and in removal of obstructions generally between Breckenridge and the northern boundary line.

The Red River of the North from its source to the international boundary line is wholly within the customs district of Minnesota, of which Saint Vincent is the chief port of entry. Collections for year ending December 31, 1887, $14,151.89; domestic exports for same period, $716,426.

Abstract of appropriations made for improving Red River of the North, Minnesota and Dakota.

By act approved—	
August 14, 1876	$10,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	20,000.00
March 3, 1881	18,000.00
By act passed August 2, 1882	10,000.00
By act approved—	
July 5, 1884	10,000.00
August 5, 1886	46,947.65
Total	169,947.65

Money statement.

July 1, 1887, amount available	$22,065.61
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,330.48
July 1, 1888, balance available	9,735.13
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	29,735.13
Amount (estimated) required for completion of existing project	59,598.37
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

CONDENSED STATISTICS.

Comparative statement of freight moved by steam-boats on the Red River of the North, Minnesota and Dakota, for nine years, 1879 *to* 1887.

Years.	Pounds.	Years.	Pounds.	Years.	Pounds.
1879	35,718,731	1882	63,303,629	1885	46,085,499
1880	43,301,515	1883	50,627,951	1886	21,013,657
1881	53,114,861	1884	58,091,472	1887	24,928,890

Z 9.

CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS, ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

No work of construction has ever been undertaken upon this proposed improvement. By the river and harbor act of Congress approved August 5, 1886, the money theretofore appropriated for the work was transferred to the general improvement of the Red River of the North. (See Annual Report, 1887.)

Z 10.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for *such work*. For account in detail of

these surveys reference is made to pages 1507 and 1508, Appendix Y, Part II, Annual Report of the Chief of Engineers, 1886.

Money statement.

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$50,000.00

Z 11.

IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA.

Capt. Clinton B. Sears, Corps of Engineers, in charge to April 16, 1888; since that date in charge of Maj. Charles J. Allen, Corps of Engineers.

The work of improvement is at present confined to the extent of river from Fort Benton to Carroll, beginning at the former point and working thence down-stream, constructing wing-dams and dams to close secondary channels so as to contract the water-way where too wide and to raise the water on the rapids so as to reduce the slopes; and dredging out the heavier gravel-bars, and removing projecting rock and loose bowlders where necessary. By the ultimate completion of the project it was expected to secure a navigable channel of 4½ feet depth at low water over the river from Fort Benton to Carroll. Cost of completing the improvement after the expenditure of the sum of $60,000 appropriated by act of Congress approved August 5, 1886, estimated at $250,000.

The original condition of the navigable channel between the points named was extremely bad at low-water stages, the depth only averaging 3 feet, the channel having many sharp turns and being obstructed in many places by projecting embedded rocks and loose bowlders.

The original project for the improvement of the river between Sioux City and Fort Benton comprised removal of snags from the lower or sandy portion, and on the upper or rocky portion the contraction of the water-way so as to afford a navigable channel of 4½ feet depth at low-water.

On this project the expenditure to June 30, 1886, was $202,456.87. At that date the channel for purposes of navigation was much better than at any previous period, and vessels loaded to 3½ feet draught could, by careful pilotage and hard rubbing on the bottom, reach Fort Benton.

The foregoing are derived from the Annual Report of the Chief of Engineers for 1887 and from Appendix X thereto.

Memoranda furnished by Captain Sears show the extent of operations during the past fiscal year.

Active construction work began July 12, 1887, and was carried on to October 18, being for eighty-five actual working days.

Three dams of brush and gravel were built at Shonkin Bar; total length of the three dams, 750 feet. One thousand seven hundred and twenty cubic yards of gravel were dredged from the shoalest places in the channel opposite the dams, 1,037 cubic yards of which were incorporated in the dams.

The result of the work was the betterment of the channel depth by at least 6 inches, enabling boats to get by without material difficulty.

At Crocondunez six dams were built, aggregating 1,200 feet in length.

Three thousand seven hundred and seventy-four cubic yards of gravel were dredged from the shoalest place in the channel, 3,484 yards of which were placed in the dams.

The result was a decided betterment of the channel to the extent of 1 foot in least depth. This locality, before work of improvement, was the worst on the upper river and had been caused by a land-slide from the north bank. Another slide, however, has since then occurred, seriously injuring navigation.

Two small dams were built near Rowe's Ranche, a few miles below the Crocondunez, to close the head of a chute. Their aggregate length is 308 feet.

Work was suspended October 20 on account of the approach of cold weather. The fleet was assembled and put into winter quarters at Rowe's Bayou, 10 or 12 miles below Fort Benton, on the south side of the river, and placed in charge of watchmen.

The steamer *Josephine* then moved down the river with the working party, stopping three days at Fort Buford to haul out of the water the plant pertaining to the improvement of the Yellowstone River; thence to Bismarck, where the working party was disbanded. The steamer was then laid up for the winter at Rock Haven, Dak., about 4 miles above Bismarck, and placed in charge of a watchman.

The work of improvement was performed by hired labor.

Captain Sears, in his last annual report upon the Missouri River from Sioux City to Fort Benton, states as follows (see pages 1599, 1600, Appendix X to the Annual Report of the Chief of Engineers for 1887):

The river from Carroll to Sioux City is very different in character from that above, flowing as it does between unstable banks and abounding in shifting sand-bars. No recommendation for the improvement of this portion of the river can be made until a thorough survey has been completed whereon to base a well digested project. The funds at command do not justify such a survey. * * *

Temporary betterment can be afforded by keeping this portion of the river free from snags. As Congress has heretofore by its legislation made snagging operations a matter separate from river improvement, this, perhaps, should be the subject of report and recommendation by the engineer officer in charge of snag-boats on the Missouri River.

Commerce on the Missouri River, between Sioux City, Iowa, and Fort Benton, Mont., has been steadily falling off year by year as the railroads have reached or paralleled and passed beyond it. The completion of the Manitoba Railroad from Saint Paul to Helena, Mont., *via* Forts Buford, Assiniboine, and Benton, a matter certain of accomplishment before another navigation season, will completely parallel the river above Fort Buford, and will greatly reduce the present commerce over this section of the river.

The Benton Transportation Company operates the only steamers now running on the upper river, and, in anticipation of the completion of the Manitoba Road, is preparing to withdraw several of its steamers. After that the navigation interests will be small and confined to a local trade, which for a number of years can not be great, as the bordering country is sparsely settled, and much of it closed against settlement by reservations for the use of Indians.

As far as benefiting any navigation interests, present or prospective, is concerned, I see no use in spending any great amount on improving the Upper Missouri River.

There is another view of the matter, however, that may commend itself as an affair of wise public policy. As long as there is, during the season of navigation, a good permanent channel extending from the Mississippi Valley into the heart of Montana, so long will the public be benefited by lower freight rates on competing railroads. This channel may never be used, but its mere existence, ready for use, will act powerfully as a check on extortionate freight rates.

On this account I recommend for the fiscal year ending June 30, 1889, for the Missouri River, from Sioux City, Iowa, to Fort Benton, Mont., an appropriation of $160,000.

Of this I recommend that $110,000 be devoted to the permanent improvement of the rocky portion of the river from Carroll to Fort Benton under the present project, and $50,000 to the removal of snags from the lower and sandy portion from Carroll to Sioux City. I would also recommend that Congress be asked to specify what proportion of

the total appropriation shall be used for snagging, should the amount appropriated be less than that asked for.

This may appear a larger amount than necessary, considering the interests involved, and so it would be were the work to be carried on in the neighborhood of material, labor, and supplies.

The work, owing to its isolated situation, must necessarily be very expensive. Fuel is very scarce and high in price, and natural material, as brush and stone, is at many places difficult and expensive to obtain.

Freight rates are high, and the distances over which supplies must be carried are very great.

Since that report was written, the Saint Paul, Minneapolis and Manitoba Railway has been extended to Helena.

Expended on present project to June 30, 1886	*$202,456.87
Expended on same during the year ending June 30, 1887, including outstanding liabilities	*29,362.49
Expended on same during the year ending June 30, 1888, including outstanding liabilities	30,639.17

It is estimated that the sum of $110,000 can be profitably expended during the fiscal year ending June 30, 1890, in furtherance of the present project of improvement upon the river between Fort Benton and Carroll, and that the sum of $50,000 in addition should be appropriated for the same fiscal year for snagging operations.

An effort was made to obtain navigation statistics of the river for the year 1887 and for 1888 to date, but without success, answers not having been received from the parties to whom application was made for the information needed. The statistics pertaining to the last annual report are, therefore, reproduced here and marked A, B, and C.

Money statement.

July 1, 1887, amount available		$30,639.17
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$30,359.83	
July 1, 1888, outstanding liabilities	279.34	
		30,639.17

Amount (estimated) required for completion of existing project† above Carroll	250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	160,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

A.

BENTON TRANSPORTATION COMPANY,
MISSOURI RIVER STEAMERS,
Bismarck, Dak., July 20, 1887.

DEAR SIR: I herewith inclose you statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, and between Fort Benton, Mont., and Bismarck during the year 1886; also from 1st of April to 1st of July during season of 1887. Of course the 1887 statement does not show the wool business, shipments of which are usually made after July 1. Wool shipments this year promise to be heavier than ever before; will amount to about 5,000 bales, value about $300,000.

Yours, truly,

I. P. BAKER,
General Superintendent.

Capt. C. B. SEARS,
United States Engineers.

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* See page 216, Annual Report, 1887.
† No project for river below Carroll except snagging.

B.

Statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, Dak., and between Fort Benton, Mont., and Bismarck, Dak., 1886.

ABOVE BISMARCK.

Trips up, 23:	
General merchandise carried, 5,750 tons	$1,500,000
Trips down, 23:	
Sacks wool (3,800), 1,064,000 pounds	234,080
Hides, peltries, furs, and merchandise, 1,000,000 pounds	50,000
Grain, 600,000 pounds	6,000
Passengers carried	400

BELOW BISMARCK.

Trips, 20:	
General merchandise carried, 5,000 tons	$287,000
Passengers carried	1,500

C.

Statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, Dak., and between Fort Benton, Mont., and Bismarck, Dak., to July 1, 1887.

ABOVE BISMARCK.

Trips up, 25:	
General merchandise carried, 6,875 tons	$2,300,000
Down-stream:	
Wool, hides, furs, and merchandise, 320 tons	
Passengers carried	610

BELOW BISMARCK.

Trips, 10:	
General merchandise, tons carried, 1,600	$144,000
Passengers carried	250

[NOTE.—Much of the up-river tonnage above Bismarck represents railroad material and supplies for the building of the Manitoba Railroad. It is abnormal in quantity and value.—C. B. S.]

Z 12.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

This work was in charge of Capt. C. B. Sears, Corps of Engineers, until April 16, 1888. Since that date the work has been in charge of Maj. C. J. Allen, Corps of Engineers.

The present approved project is to work down the river from Glendive in order to repair existing dams and build new wing-dams and dams to close island chutes where necessary, so as to confine the water to one channel and thus increase the depth on the rapids and shoal places generally. Also, to remove rocks and bowlders from the channels. (See Appendix to Annual Report of the Chief of Engineers for 1887.)

For reasons given in the same appendix by my predecessor in charge, one of them being the inadequacy of the appropriation of 1886 to repair the plant and perform sufficient work to justify the cost of repairs and of new outfit, no work for improvement was undertaken during the past fiscal year, the project being suspended until the whole matter could be reported to Congress.

The plant, which was lying at Ward's Ranche, about 25 miles below Glendive, was repaired sufficiently to be floated down the river during the season of 1887 and placed in security at Fort Buford.

The appendix to the last annual report states as follows:

The Yellowstone, for a swift, snow-fed river, is an excellent one naturally, and susceptible of radical improvement at a relatively small expense, considering its distance from labor and supply markets. Though not at present navigated, the existence of a good navigable channel will always be a check on high railroad tariffs to competing points on the river.

If Congress deem this a sufficient cause for the continuation of the improvement, $50,000 in addition to the present available balance can be profitably expended during the fiscal year ending June 30, 1889.

So far as learned, there are no boats engaged in navigating this river, and there is no immediate prospect of any being put on it.

The funds that were available at the commencement of the last fiscal year having been reduced in consequence of repair to and care of plant and other contingencies, the estimate for the fiscal year ending June 30, 1890, should Congress continue the improvement, is placed at $65,000.

Expended during the year ending June 30, 1888, including outstanding liabilities, $3,269.85.

Total expended upon this improvement to June 30, 1888, including outstanding liabilities, $104,489.27.

Money statement.

July 1, 1887, amount available	$16,530.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,269.85
July 1, 1888, balance available	13,260.98
Amount (estimated) required for completion of existing project	106,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	65,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Z 13.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER BETWEEN SAINT PAUL AND SAINT ANTHONY'S FALLS, MINNESOTA.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., December 8, 1886.

GENERAL: I have the honor to submit the following in regard to a preliminary examination of the Mississippi River between Saint Paul and Saint Anthony's Falls, Minnesota, made in accordance with the provisions of sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

The distance by river from the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge, at Saint Paul, to the falls is about 13 miles. About 2½ miles above the bridge the Minnesota River enters the Mississippi, being separated from it by Pike Island, which extends for about 1½ miles above the junction to Fort Snelling. Between the island and Fort Snelling there is a narrow channel connecting the two rivers, the current flowing from one to the other, according to the relative stages of water in the rivers.

Fort Snelling is distant 9 miles from the falls, and is 5½ miles below Meeker's Island, the site of a proposed lock and dam. Minnehaha Landing is about 1½ miles above Fort Snelling. About 1½ miles below the Falls

of Saint Anthony are two steam-boat landings; that on the right bank known as Murphy's, the other, on the east bank, known as Cheever's.

The portion of river under consideration was thoroughly surveyed in 1867 by Maj. G. K. Warren, of the Corps of Engineers, and it was again surveyed in 1879, under my direction, by Assistant Engineer F. Terry, though no estimate of cost of improvement was made at the time, it not being then considered necessary. Other examinations were made with a view of ascertaining the practicability and cost of a lock and dam navigation. The principal, as well as the last, examination made with reference to a lock and dam was by Major Farquhar, Corps of Engineers, in 1873, and the resulting estimate of cost for a dam of 17 feet lift, with lock, at Meeker's Island, was placed at $922,121.46. This examination would have been more satisfactory had there been sufficient funds available for it to have admitted of extending the borings.

Congress, by act approved July 23, 1868, granted to the State of Minnesota 200,000 acres of land to aid in the construction of a lock and dam at Meeker's Island, and, by act approved March 3, 1873, appropriated $25,000 for the proposed work, its use, however, being made conditional upon the full relinquishment by the State to the United States of the right to the grant of 1868. The relinquishment has never been made, consequently no work has been undertaken towards the construction of the lock and dam. Should this proposed work be built, full improvement of the channel from Saint Paul to Meeker's Island would become necessary.

In 1869 Captain (now Major) Stickney, of the Corps of Engineers, in a report to Major Warren of an examination of the river from the steam-boat landings below the falls to the mouth of the Minnesota River, estimated the cost of making a channel between the points named, with depth of 4 feet and width of 200 feet on the rapids, by the removal of 3,725 cubic yards of rock and bowlders from the bed of the stream, at $29,800. This did not include the cost of removing sand-bars, which, it was then thought, could be effected so far as necessary by the dredge-boats then in use.

From examination of the map of 1879 it appears that, in addition to bowlders, more or less of sand-bars would have to be removed between Meeker's Island and the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge (this bridge being the lower terminus of the survey of 1879), in order to secure a 4-foot channel of sufficient width at the ordinary low-water stage.

The recent examination was delayed by snow-storms, intense cold, and running ice. Assistant Engineer F. T. Hampton, accompanied by Assistant Engineer R. Davenport, reconnoitered the river from the falls to Saint Paul on the 2d and 3d instant, and, so far as they were able to observe, no changes appeared to have occurred since 1869 to materially affect the estimate of that year, which covered the removal of bowlders and rock. The extent of changes in depths, or in positions of bars, between Meeker's Island and the railway bridge at Saint Paul, since 1879, due to movement of sand, gravel, or to saw-mill refuse, can only be ascertained by full survey. And a close and comprehensive survey would be required from which to determine the cost of adequately improving the river from Saint Paul to the falls, whether by means of wing-dams and removal of rock and bowlders throughout the entire distance, or by means of a lock and dam at Meeker's Island, or locks and dams from the island to the falls, and by removal of bowlders, etc., and contraction of the low-water channels by means of wing-dams from the island to Saint Paul.

Beyond navigation by a small steamer from Saint Paul to Fort Snelling and Minnehaha Landing, and occasional trips of the same steamer to points near the falls, and the running of loose saw-logs, there is no river commerce to report between the falls and the mouth of the Minnesota River. It is claimed, however, that, were the difficulties in the way of navigation simply lessened by the removal of the bowlders, etc., light-draught steamers would ascend regularly to the Minneapolis landings, and that boats of a larger class would follow an adequate improvement of the whole stretch from the landings to the wharves at Saint Paul; this latter in view of the fact that large steamers from the lower river can now reach Saint Paul at all times during the season of navigation as a consequence of the Government river improvement.

Capt. John C. Reno, in a letter dated Minneapolis, October 2, 1885, and addressed to the secretary of the Northwestern Water-ways Convention held at Saint Paul in September, 1885, stated that, during the season of 1857, there were 52 arrivals of steamers at the Minneapolis landings, delivering over 12,000 tons of miscellaneous freight for that place and for the valley above it.

STATISTICS, MINNEAPOLIS, MINNESOTA.

Movement of wheat, flour, etc., at Minneapolis, for the crop year ending September 1, 1885, *crop of* 1884.

		Receipts.	Shipments.
Wheat	bushels	32,112,840	5,584,320
Flour	barrels	23,378	5,298,941
Mill-stuff	tons	3,003	142,815

Movement of wheat and flour for the crop year commencing September, 1885, *and ending August* 31, 1886.

		Receipts.	Shipments.
Wheat	bushels	32,736,950	4,929,239
Flour	barrels	21,766	5,428,581

Export of flour from Minneapolis to foreign countries in 1884 amounted to.....barrels.. 1,805,876
In 1885 it amounted to.....do... 1,876,000

The production of lumber at Minneapolis for sixteen years past has ranged from 118,000,000 feet, B. M., to 312,000,000 feet, B. M.

The amount received and forwarded for the ten years ending in 1884 has averaged as follows: Received, 10,600,000 to 67,970,000 feet, B. M.; shipped, 93,000,000 to 186,700,000 feet, B. M.

Miscellaneous manufacturing for the ten years ending 1885 has ranged in value from $4,000,000 to $28,000,000,

I am of opinion that the Mississippi River from Saint Paul to Saint Anthony's Falls is worthy of improvement by the General Government, and that a full survey of it should be made from which to ascertain the most practicable method of permanently improving it, and the cost of the same.

The least cost of the survey required from which to make proper maps, drawings, and estimates of cost of improvement I place at $1,000.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF MISSISSIPPI RIVER BETWEEN SAINT PAUL AND SAINT ANTHONY'S FALLS, MINNESOTA.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., December 29, 1887.

SIR: I have the honor to submit the following report of a survey of the Mississippi River between Saint Paul and Saint Anthony's Falls, Minnesota, made during the past season in conformity with the requirements of sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

The survey commenced in the latter part of June and was carried as far as the funds at command admitted of. The amount of funds did not admit of borings in the bed of the river, or of making detail drawings of works projected for improvement. Borings are especially needed in order that the cost of foundations for locks and dams may be closely estimated, and the sum of $3,000 can be advantageously expended for that purpose.

The survey extended from the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge at Saint Paul to the foot of the apron at the Falls of Saint Anthony. It consisted of a stadia line on one bank of the river from which were located the bars and islands, checked by a carefully run transit line on the other bank; also, of a line of levels from the falls to the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge, from which point levels were also run to connect with the gauge on the pier of the Wabasha Street Bridge at Saint Paul as well as with the gauge of the United States Signal Service. The elevations of the water-surface were taken at intervals of about 1,000 feet, excepting where sharp changes in slope occurred, when they were taken at shorter intervals. The elevations of the tops of the islands between the mouth of the Minnesota and the rapids below the falls were also taken, and bench-marks for future reference were established about one-half mile apart. The dimensions of the bridges within the limits of the survey were also measured and the bridges located upon the maps of the survey. In addition the river was sounded to within 1¼ miles of the foot of the falls. Soundings were also taken on the lines of the Washington Avenue and Northern Pacific Railroad bridges, below the falls. The sounding of portions of the stream where rapids existed was effected by stretching a strong rope from bank to bank by means of a windlass, and even with this precaution it was difficult to hold the sounding-boat in place.

The river between Saint Paul and Saint Anthony's Falls was surveyed in 1867 and again in 1879. A survey was also made in 1873 with a view to a lock and dam at Meeker's Island. This last-named survey consisted principally of soundings in the vicinity of the island, and of a line of levels from Minneapolis to a point about 1,000 feet below the island.

One object of the recent survey was to extend the soundings further than had been done in former surveys.

The surveying party was in charge of Mr. Archibald Johnson, assistant engineer, assisted by Mr. L. C. Hill. To these gentlemen I am indebted for careful and conscientious field work. To Mr. Johnson I am also indebted for material assistance in estimates of cost of improvements.

Of the survey, Mr. Johnson reports:

The length of the river from the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge to Saint Anthony Falls is 12 miles and 1,510 feet. The fall from the sur-

face of the water on the lower rolling dam at Saint Anthony Falls to the Chicago, Saint Paul, Minneapolis and Omaha Bridge at the time of the survey was 98.617 feet and from the foot of the falls 55.35 feet. The bluffs along the valley of the river are from 80 to 120 feet high. They are composed of drift from 20 to 30 feet thick; then a stratum of magnesian limestone from 20 to 30 feet thick, overlying a soft sand-rock nearly destitute of cement. It will stand with a slight slope, but when blasted it goes to sand. The bed of the river from the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge to the foot of Pike Island seems to be sand and silt; but from this point to the head of Meeker's Island it consists of sand, gravel, and occasionally small bowlders to a depth at present unknown. From the head of Meeker's Island to the foot of the falls the bed of the river is composed of sand, gravel, bowlders, and masses of limestone which fell from the limestone formation as the falls were receding.

As no borings have ever been made from the Franklin Avenue Bridge to Fort Snelling, at least to the sand-rock, the character of the material overlying the sand-rock can only be conjectured. There is reason to believe, however, that there is considerable rock in the deposit. The only information that could be obtained of the character of the material over the sand-rock was from the corporations that built the various bridges across the river. At the stone viaduct, just below the falls, the distance to the sand-rock was only a few feet. The piers of the Tenth Avenue Bridge were founded on the débris in the channel. At the Saint Paul and Northern Pacific Railroad Bridge borings were made from bluff to bluff. There are only a few feet to the sand-rock in the channel, but from the right bank, at low water, to the bluff there is a maximum depth of 45 feet to the sand-rock. The material was sand, gravel, and pieces of limestone. The piers of the Washington Avenue Bridge are founded on débris in the channel. The piers of the Franklin Avenue Bridge are founded on the sand-rock, and the depth to it is from 7 to 14 feet. At the Chicago, Milwaukee and Saint Paul Short Line Bridge the piers are founded on the limestone débris. At the proposed Marshall Avenue Bridge one boring was made on the island to a depth of 20 feet below low water, and nothing but sand and coarse gravel was found, and the pier is to be founded on that. At Fort Snelling piling was driven for three piers. This is all the information we have at present in regard to the bed of the river.

The profile shows the depth of water in the channel with reference to the low water of 1864, which has been taken at +0.1 foot on the United States Signal Service, of +0.5 on the Wabasha Street Bridge gauge. It also shows the high-water line of 1867, from the falls to Fort Snelling, which is 16.5 feet above low water. Below Fort Snelling the high-water mark of 1867 has not been found, and it is not shown on the profile. The high water of 1867 was the highest ever known at Minneapolis, with the exception of that of 1850, which is said to have been about 40 inches higher than that of 1867, but the marks that were made at the time of that flood have been obliterated long ago. At Saint Paul it read 23 feet 10 inches on the gauge, but there is no record of the elevation of the zero of that gauge. The elevation of the high-water mark of 1867 at the cave opposite Heinreich's brewery and just below the Washington Avenue Bridge is 730.97 above sea-level, or 16.5 feet above the low water of 1864.

On comparing the map of this survey with that of 1867, 1873, and 1879, it will be seen that there have been but slight changes in the regimen of the river since the first survey, excepting a deepening of the channel along the Saint Paul Boom Company's boom, just below the mouth of the Minnesota River, and a cutting of the right bank.

The silt referred to in the bed of the Mississippi is doubtless largely due to contributions from the Minnesota River, brought down by floods. There are also in the bed of the river, within the limits of the survey, masses of water-logged slabs and other refuse from saw-mills at the falls.

The great flood of 1881, at Saint Paul, reached at its highest point 19.70 feet, on the gauge at the Wabasha Street Bridge. This flood is described in pages 1754–56, Appendix W, to the Annual Report of the Chief of Engineers for 1881.

For convenience of reference the following data are tabulated:

TABLE No. 1.

From—	To—	Distance by channel of the river.	Average width.	Ruling depth at low water.	Fall of water surface at time of survey.	Observed maximum surface velocity per second during the survey.
		Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Chicago, St. Paul, Minneapolis and Omaha Railway Bridge.	Foot of Pike Island	2.551	800	3.5	2.120	.....
Foot of Pike Island	Fort Snelling Bridge	1.600	560	1.5	3.020	.....
Fort Snelling Bridge	Minnehaha Creek	1.780	600	2.0	2.000	.....
Minnehaha Creek	Foot of Meeker's Island	3.540	700	1.5	11.774	.....
Foot of Meeker's Island	Head of Meeker's Island	0.392	600	2.5	2.814	5.31
Head of Meeker's Island	Foot of rapids	0.132	570	1.5	0.717	4.49
Foot of rapids*	Head of rapids	0.538	600	2.0	5.315	6.50
Head of rapids	Upper steamboat landing, Minneapolis.	0.538	500	3.0	2.806	4.75
Upper steam-boat landing	Tenth Avenue Bridge, Minneapolis.	1.000	450	.....	15.410	.....
Tenth Avenue Bridge	Foot of apron at St. Anthony's Falls.	0.316	.....	.....	9.320	.....

*These are the worst rapids below the upper steam-boat landing. They are caused by a steep fall over masses of bowlders, gravel, limestone blocks, etc.

REMARKS.—The average widths given in this table are those existing at the time of the survey, and include widths behind islands. The ruling depths given in the table are from the soundings of the survey, reduced to the low water of 1864. The average stage of water at the signal-service gauge, Saint Paul, during the survey was 2.5 feet.

Between the Fort Snelling Reservation and Pike Island is a narrow channel, nearly dry at time of low water, connecting the Mississippi and Minnesota rivers, the current setting from one to the other, according to the relative stages of the streams.

The Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge has, commencing at the right bank of the river, one through span, 150 feet in width between centers of piers; next, a draw, with clear opening on each side of the pivot pier of 114 feet; then six spans 150 feet in width each from centers.

Crossing the river just below the Falls of St. Anthony, and beyond the limits of any probable navigation, is the great stone viaduct of the Saint Paul, Minneapolis and Manitoba Railway, affording clear height under crown of arch of 63 feet above low-water mark.

Between these two bridges are existing and projected bridges, as follows:

TABLE No. 2.

Name of bridge.	Distance from Chicago, Saint Paul, Minneapolis, and Omaha Ry. Bridge.	Elevation of bottom chord above low water.	Range between high and low water.	Clear widths under spans at low-water mark.		
				Main span over channel.	Other spans.	Total.
Existing bridges.	*Miles.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Fort Snelling Highway	4.15	84.5	16.5	240	170	410
Chicago, Milwaukee and Saint Paul Railway	9.43	107.2	16.5	315	190	505
Washington Avenue, Minneapolis, Highway	11.29	60.8	16.5	150	115	265
Saint Paul and Northern Pacific R. R., Minneapolis	11.42	52.6	16.5	185	125	310
Tenth Avenue, Minneapolis, Highway	12.12	41.7	16.5	190	520	710
Projected bridges.						
Marshall Avenue Highway*	8.69	†108.0	16.5	350	220	570
Franklin Avenue Highway*	10.01	96.5	16.5	290	320	610

* The piers of the Marshall Avenue Bridge are not yet commenced. Those of the Franklin Avenue Bridge are nearly completed.

† *Clear height under crown of iron arch.*

The area of drainage basin tributary to the Mississippi River at Saint Paul is about 35,600 square miles, of which 16,000 square miles appertain to the basin of the Minnesota River. The area tributary to the Mississippi at the Falls of St. Anthony is, therefore, about 19,600 square miles, the area supplying the river between the falls and Fort Snelling being so small in comparison with the figures just given that, for the purposes of this report, it may be neglected.

The stage of water at Saint Paul is thus dependent upon the stages of two streams with drainage basins of nearly equal areas, though not possessing over their areas equal average annual precipitation. The open, cultivated, and less-timbered basin of the Minnesota is more subject to violent freshets, followed by prolonged periods of extreme low water in its streams, than is the basin of the Mississippi above Minneapolis, with its as yet largely timbered areas and large lakes. The greatest flood volume at the mouth of the Minnesota is probably not less than 150,000 cubic feet per second, while the flood volume of the Mississippi at the Falls of St. Anthony, from an area but 23 per cent. greater than that of the Minnesota, is estimated at 50,000 cubic feet per second, though it is probable that the flood volume of 1850 largely exceeded that figure.

The low-water volume of the Minnesota River, at its mouth, averages 700 cubic feet per second. In 1886 it fell at one time to 470 cubic feet. The low-water volume of the Mississippi at the Falls of St. Anthony rarely falls below 4,000 cubic feet per second. These refer to measured volumes when the streams are open. The winter volume at the falls was, upon one occasion, found to be 2,300 cubic feet per second.

The lowest water at Saint Paul (when the river is not frozen over) of which we have any record, is that of 1864. The average annual precipitation (rain and melted snow) at Saint Paul, from observations covering thirteen years, is 30 inches. In 1863 the total precipitation was 15.67 inches; in 1864, but 14.74 inches; or, the total for the two consecutive years but one-half an inch more than the average precipitation for one year. From comparison of measurements of the volumes of river discharge at Saint Paul, at different readings of the gauge during low-water stages, it is most probable that the lowest-water volume of 1864, at Saint Paul, was considerably less than 3,000 cubic feet per second.

From a number of measurements of the river volume passing Saint Paul at a 2-foot stage on the United States Signal Service gauge, the average volume at that stage is taken as 5,200 cubic feet per second, in which is included the average low-water contribution of the Minnesota River. A 2-foot stage on the United States Signal Service gauge is here taken as ordinarily low water, and as at such stage the volume of the Minnesota has generally averaged less than 1,000 cubic feet per second, we have in the Mississippi, above Fort Snelling, a volume somewhat in excess of 4,000 cubic feet per second to consider in projecting any plan for improvement at ordinarily low-water stage.

During the progress of the recent survey a gauge-rod was established at the Northern Pacific Railroad Bridge below the falls. This gauge was read daily, and its readings compared with those of the Signal Service gauge at Saint Paul. Although the operations of the mills at Minneapolis caused frequent fluctuation of water-surface at the upper gauge, a close agreement in the readings of the two gauges, allowing for distance, was observed. This was doubtless due to the Minnesota River remaining at a very low and almost unvarying stage during the season. *The soundings*, therefore, taken during the season, are of particular *value.*

The operations of the four reservoir dams at the headwaters of the Mississippi River have, for the greater part of the dry seasons of 1885, 1886, and 1887, undoubtedly maintained the stage of the river at Saint Paul from 1 foot to 1½ feet higher than would have been the case had they not been built and operated. These reservoirs, if maintained and operated in the interest of steam-boat navigation, for which purpose they were created, can undoubtedly be depended upon to prevent the river at Saint Paul from again falling during the season of navigation to as low a point as it did in 1864.

Floods from the Minnesota River affect the stage of the Mississippi River for 6 to 8 miles above Fort Snelling.

Improvement of the navigation of the Mississippi between Saint Paul and St. Anthony's Falls has never, as yet, been considered by Congress, excepting for that portion of the river at and above Meeker's Island.

An act of Congress approved July 23, 1868, granted 200,000 acres of land to the State of Minnesota to aid in constructing a lock and dam at Meeker's Island. By act approved March 3, 1873, Congress appropriated the sum of $25,000 for construction of this proposed lock and dam, with the proviso—

> That all rights and claims in and to the land grant made to the State of Minnesota for the above work by act approved July 23, 1868, shall be fully relinquished to the United States before any of this appropriation is expended.

As no relinquishment to the United States has been made, the appropriation of $25,000 remains unexpended.

An estimate of the cost of this proposed lock and dam, rendered in 1874, but based upon limited information as to the nature of foundation to build upon, placed it at $922,121.46. The lock-chamber was to be 300 feet long by 80 feet wide, and the work was only calculated for locking at ordinarily low-water stage. The object of the work was the extension of navigation to the old steam-boat landings at Minneapolis, below the present Washington Avenue Bridge; but a single lock at Meeker's Island would not prove sufficient, for, in order that steamers with large barges from the lower river may reach the site of the proposed lock at low-water stage, the river must be improved up to the site of the lock.

According to the best information I am able to obtain, large steamers of 350 to 700 tons carrying capacity made frequent trips to Saint Anthony and Minneapolis before those places, now forming the city of Minneapolis, were connected by railroad with Saint Paul. Those steamers made their trips during ordinarily high water (not during floods), sometimes towing large loaded barges, in which case they were obliged to use a line in order to make the ascent of the rapids above Meeker's Island. Most of the freight was left at Cheever's Landing, on the left bank of the river and about one-third of a mile below the present Washington Avenue Bridge. There is another landing on the right bank, referred to in Table No. 1, accompanying this report, as the Upper Landing, and about 900 feet below the Washington Avenue Bridge, which was occasionally reached by steamers during high water; and still another on the left bank, about 2,400 feet above the same bridge, which was reached a few times by steamers with the aid of a line.

There was also a landing at the foot of Meeker's Island, where boats were unloaded in case they failed to ascend the rapids.

During moderately low water, small steamers, without barges, have reached the landings below the Washington Avenue Bridge.

Capt. John C. Reno, of Minneapolis, in a letter dated October 2, 1885, and addressed to the State river commission, reports fifty-two arrivals

of steamers at the Minneapolis landings in 1857, delivering over 12,000 tons of miscellaneous freight.

At present steamers rarely ascend the Mississippi above the head of Pike Island, a small excursion steamer excepted, which makes trips to Minnehaha Landing, at the mouth of Minnehaha Creek, during favorable stages of water.

The Mississippi River from the Chicago, Saint Paul, Minneapolis and Omaha Railway Bridge to the landing below the Washington Avenue Bridge, Minneapolis, can be improved by dredging the sand and gravel bars, contraction of the low-water channel below Meeker's Island by means of wing-dams and dams to close secondary channels, and by the removal of bowlders and rock from the main channel, to admit of steamers of moderate draught reaching the landings when the water on the rapids is at a stage of 3 feet and upwards above low water. If the steamers tow barges a line will be needed, more or less, for warping over the rapids. Such improvement, while of some benefit to navigation, will not meet the demands of an extensive river traffic between Minneapolis and lower river ports. The cost of such improvement will be, approximately, as follows:

Removal, by dredging, of 40,000 cubic yards gravel and sand, at 30 cents	$12,000
Removal of 20,000 cubic yards hard material, as gravel, small bowlders, and broken rock, in order to widen and deepen the channel at the rapids, at $3.	60,000
Removal of 3,000 cubic yards large bowlders, mostly from channel at the rapids, at $8	24,000
10,000 linear feet dams and revetment, at $5	50,000
Total	146,000

An improvement to meet the demands of an extensive river traffic, by providing for the passage at low as well as high stages of the river of steamers with barges drawing 4 feet of water, can be effected by the removal of shoals and contraction of the channel by means of wing and closing dams to a point 2,400 feet above the mouth of Minnehaha Creek; thence to the Minneapolis landings, by means of locks and dams to overcome the strong current existing in the Mississippi above the mouth of the creek. To carry the improvement to the landing just below Washington Avenue Bridge will require two locks and dams of lifts, and located as follows:

Lock and dam No. 1, of 9½ feet lift, about 2,400 feet above the mouth of Minnehaha Creek.

Lock and dam No. 2, of 15½ feet lift, at a point 2 miles and 4,510 feet above Lock No. 1, or 1,100 feet below Meeker's Island.

Should the site for No. 2 prove, after further examinations and borings, unfavorable for a lock of 15½ feet lift, Lock No. 1 may possibly be made for a 15½-foot lift, and Lock No. 2 for a 9½-foot lift, and located at the line A–B, about 400 feet above the head of Meeker's Island. (See Tracings Nos. 2 and 3, herewith.)

Should it be desired to extend the slackwater improvement to the Tenth Avenue Bridge, Minneapolis, a third lock and dam, of 13 feet lift, will be required at a point about 500 feet below the Washington Avenue Bridge; or, should this prove unfavorable, the lock and dam may be located further down-stream at the line C–D. (See Tracing No. 3.)

If navigation is to be carried above the Washington Avenue Bridge, that bridge and the Northern Pacific Railroad Bridge immediately above it must be provided with draws.

Before the construction of locks is commenced a survey in detail, including numerous borings, must be made at each of the above-named sites.

The locks must be of capacity to admit of the passage of steamers with barges of the size that now go through the locks of the Des Moines Rapids Canal. The lock chambers should not be less than 80 feet in width and 360 feet in length between centers of quoin posts. The locks should be furnished with upper-guard gates, and the lock-walls should be carried up to at least 3 feet above the highest water-mark and proportioned so as to admit of the locks being operated at all stages of the river. The locks should be lighted by the electric light and the gates and wickets operated by machinery, for all of which the power of the stream may be utilized. Each dam should be provided with a sluice or a roll-way to admit of the passage of saw-logs. The dams may be built of crib-work filled with stone, but they should be joined into masonry abutments and be securely founded upon the bed of the river, and be provided with aprons on their down-stream side of from 60 to 70 feet in length to secure the dams against the undermining effects of floods.

The locks should be of masonry. The following estimates are for timber-dams as described, and masonry locks, the horizontal dimensions of the locks as follows:

	Feet
Length of chamber between centres of quoin-posts	360
Width of chamber	80
Distance from center of quoin-post of upper gate to center of quoin-post of guard gate	76
Length of head-bay from center of guard-gate quoin-post	134
Length of tail-bay from center of lower-gate quoin-post	170

Estimates for timber dams and masonry locks.

For a lock and dam, 15½ feet lift:	
Lock	$954,000.75
Dam	223,776.71
Coffer-dam	48,800.00
	1,226,577.46
Contingencies of engineering and superintendence, 10 per cent	122,657.74
Total	1,349,235.20
For a lock and dam, 13 feet lift:	
Lock	828,370.42
Dam	165,930.46
Coffer-dam	48,800.00
	1,043,100.88
Contingencies of engineering and superintendence, 10 per cent	104,310.08
Total	1,147,410.96
For a lock and dam, 9½ feet lift:	
Lock	670,231.44
Dam	99,446.37
Coffer-dam	48,800.00
	818,477.81
Contingencies of engineering and superintendence, 10 per cent	81,847.78
Total	900,325.59

In the foregoing estimates are included gates, wickets, machinery, lock-keepers' dwellings, engine-houses, etc. Contingencies are large in view of difficult foundations.

If the slackwater navigation is to [redacted]
at Minneapolis, the lock and dam of 13 feet lift w
addition to the foregoing, increasing the cost by $
dam, if built, will cause the overflow of a small area c
side of the river, of total value probably not exceedin

It has been urged in some quarters, against the esta
water navigation below Minneapolis, that the sewag
charged into the stream from that city will be retained
to be caused by the dams than is now the case with t
to the detriment of the health of the community. Tl
be overcome by the discontinuance of the practice of
etc., into the river.

As to the value or necessity of the improvement for v
estimates are made, there is, at present, no steam-boat
sequence above the Saint Paul steam-boat landings.
that an improvement will be utilized for transpor
freight rates, of a large portion of the flour manufactu

The lumber moved from Minneapolis is almost enti
rail to the Southwest, West, and Northwest.

STATISTICS, MINNEAPOLIS, MINNESOTA.

Movement of wheat, flour, etc., at Minneapolis for the crop yea
1885:

Receipts—
- Wheat .....
- Flour .....
- Millstuff .....

Shipments—
- Wheat .....
- Flour .....
- Millstuff .....

Movement of wheat and flour for the crop year ending Septem

Receipts—
- Wheat .....
- Flour .....

Shipments—

The yearly manufacture of lumber from 1870 to 1886, both inclusive, has ranged from 117,000,000 to 313,000,000 feet, B. M.

The manufactured lumber received at and forwarded from Minneapolis for the ten years ending with 1886 has ranged as follows: Received, 10,773,000 to 67,970,000 feet, B. M.; forwarded, 93,830,000 to 186,739,000 feet, B. M.

Miscellaneous manufacturing for the ten years ending with 1885 has ranged in value from $4,000,000 to 28,000,000.

Statistics of freight received at and forwarded from Saint Paul by river are not given in this report for the reason that the river below Saint Paul, and to which these statistics pertain, is already under improvement by the Government, besides being beyond the limits of the survey here reported upon.

The following are added in conformity to the requirements of section 2 of river and harbor act of 1866.

The portion of river surveyed lies within the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which port the revenue collected for the fiscal year ending June 30, 1887, was $6,537.80.

The nearest Government buildings are a custom-house and post-office building at Saint Paul, and a post-office building at Minneapolis.

Between Saint Paul and Minneapolis is Fort Snelling.

With this report are three tracings* from maps of the surveys, upon which are indicated approximate locations for locks and dams.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, *U. S. A.*

Z 14.

PRELIMINARY EXAMINATION OF MINNESOTA RIVER WITH A VIEW TO ITS IMPROVEMENT BY LOCKS AND DAMS.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., December 10, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination of the Minnesota River, made in accordance with sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

The Minnesota River was examined and surveyed more or less from its headwaters to its mouth between 1866 and 1875. The survey of 1874, made to determine the practicability of a permanent navigation by means of locks and dams in the bed of the stream, and also by means of a canal, extended from the mouth of the river to South Bend, a distance of about 116 miles, measured along the channel. South Bend is about 3 miles above Mankato. An improvement by means of locks and movable dams appeared, from the results of the survey, to be feasible, movable dams being proposed instead of fixed dams, on account of the heavy freshets to which the valley of the Minnesota is subject, as well as on account of the movement of sand, etc., in the bed of the stream. An improvement by locks and dams for the portion of river surveyed was then estimated to cost $14,399.58 per mile, as against at least

*Omitted.

$36,365 per mile by canal, for 51 miles, that being the distance betwe the extreme points of the survey measured along the axis of the vall and the figure taken as a factor for comparing the cost of the two me ods considered.

One of the questions then, as now, was whether the prospective co merce of the valley of the Minnesota would warrant such an outlay money by the General Government.

Congress at different times, commencing in 1867, appropriated su of money for improvement of this stream, the total of the appropriatic amounting to $107,500; the last appropriation for this purpose havi been made in 1878. For the survey of 1874 $10,000 were appropriat

Although under the appropriation for improving the channels lo stretches of river were cleared of obstructions to navigation, advanta of the improvement was not taken to put boats upon the stream. was claimed, however, by many that, were the improvements extend by the construction of locks and dams, steam-boats and barges wo navigate the river and transport the products of the valley, and tl then low freight rates would be the rule.

In order to ascertain, so far as was practicable, the present conditi of things in the valley of the Minnesota, Assistant Engineer F. T. Han ton reconnoitered the river in November and visited most of the prin pal towns along its banks. Mr. Hampton encountered severe weat during the greater part of his trip and for part of the time was suc bound. He visited Le Sueur, Mankato, Redwood Falls, Granite Fal Montevideo, Ortonville, Big Stone City, and Chaska in the order nam

Above Mankato no general interest seemed to be manifested by t residents of the valley in any improvement of the river. At Manka however, it was the opposite. This place has an enterprising popu tion of about 12,000; its wealth is said to be increasing at the rate of per cent. per annum. Of Mankato Mr. Hampton reports as follows:

The principal industries are cement works, capacity 1,300 barrels per day; sto quarries, from which were shipped in 1885 2,000 car loads of stone; fire-brick and t factory, 7,000,000 fire-brick and large quantities of sewer-pipe; brick yards, 10,000,(bricks; linseed-oil mills, 70 barrels of oil daily; and several flour-mills, saw-mil foundries, and machine-shops. In 1885, 55,000,000 pounds of freight were receiv and 320,000,000 pounds freight were shipped. For the years 1883, 1884, 1885, the val of the home-manufactured and imported goods sold was $5,200,000. Producing many articles that can bear only cheap transportation, the people of Mankato n urally look to the river as a guaranty against onerous railroad rates. Yet I he here expressions of doubt that, even with improved navigation, some merchants a manufacturers would avail themselves of water transportation during the boat season on account of the policy of railroads to increase the winter tariff to make for loss of trade during the navigation months.

And of Le Sueur, 20 miles by river below Mankato, he reports:

At Le Sueur, a place of 1,800 inhabitants, I found some interest manifested in errand by the few manufacturers there. The farming population around the pl knows little and cares little for the matter of river improvement. The trade of place is on a stand, if not a decline, on account of the springing up of so many ot small towns on the railroads, which have drawn off trade from Le Sueur. I had attention called in other portions of the valley to this multiplication of shipp points at the expense of the trade of older towns.

Le Sueur grinds and ships about 350,000 bushels of wheat, produced on an area 360 square miles, and ships about 1,000,000 pounds of pork. These articles form bulk of its shipping trade. The rate by rail from Le Sueur to Minneapolis is 9 ce per 100 pounds on general merchandise; wheat, 6 cents per bushel.

I was told by a very intelligent man, who had lived in this section thirty years, t before the days of railroads he had paid steam-boats 1 cent per pound freight on c from Traverse to Judson, a distance of 18 miles, and $8 as passenger fare from M *neapolis to* Mankato, now about $2 by rail. I also learned a fact which has an *portant* bearing on this subject; farmers living within 3 miles of Le Sueur w

hauling, at time of my visit, their wheat 18 miles east of Le Sueur to another railroad, because, as they claimed, of the illiberal prices offered by the Le Sueur merchants. This fact would show how independent the numerous railroads have enabled farmers to be; and it must be due to the reason that rates are very different on competing roads, otherwise the merchants of Le Sueur would not permit their trade to depart from them.

It was difficult to obtain reliable statistics of the valley from which to draw conclusions as to the public benefit to be derived from an improvement of the river. Those supposed to be in positions to enable them to furnish statistical information did not always respond to applications for such information. Under the head of statistics Mr. Hampton reports as follows:

In the matter of commercial statistics for present year I could obtain little information that was satisfactory; it was mostly conjecture. I therefore present some figures for the year 1885, taken from the report of the State commissioner of statistics.

The question as to how much territory would be tributary to the river if improved from its mouth to Ortonville is difficult to answer, considering the numerous railroads occupying the country and more building and projected. We will suppose a strip 50 miles wide and extending the whole length of the valley to contribute its trade to the river—and this was the opinion of the business men of Mankato with whom I talked—the statistics of the following counties would then give some idea of the products of this territory.

Total area, 11,400 square miles. Population at end of 1885, 185,000. Cultivated area, 2,000 square miles.

There were raised on this area in 1885, 9,595,000 bushels wheat, 3,306,000 bushels corn, 6,810,000 bushels oats, 4,588,000 bushels barley, 360,225 bushels flaxseed, 490,000 head of stock.

These figures may be increased 10 to 12 per cent. for the year 1886.

As to how much of these products would go out by river if it were navigable and how much freight would go into the valley by the same means is only speculative.

Some of the grain would not move to market probably till late in the season, when navigation would be closed, and much of the general merchandise would go into the valley by rail on account of despatch and certainty of delivery.

In connection with this question of river transportation the growth of railroad lines in the Minnesota Valley deserves attention.

At the time of General Warren's survey, in 1866, the only line of railroad constructed and in operation west of Minneapolis was the Saint Paul and Pacific Railroad (now the Saint Paul, Minneapolis and Manitoba Railway), terminating at Saint Cloud, 73 miles from Saint Paul. To-day there are within the basin of the Minnesota River alone, not counting other parts of the State, 1,000 miles of railroad in operation, running mostly easterly and westerly, the lines which the development of the Northwest has followed. The time is now at hand when the construction of railroads on northerly and southerly lines across the Minnesota Valley must begin. These lines are demanded by the rapidly increasing populations of Iowa and Minnesota and by the increase in the consumption of Iowa coal in the Minnesota Valley.

For the twelve years from 1873 to 1885, inclusive, the average rate of tariff per ton per mile received by the three principal roads of the State—Chicago, Milwaukee and Saint Paul, Chicago and Northwestern, and Chicago, Saint Paul, Minneapolis and Omaha—was, according to the report of the railroad commissioners of Minnesota for 1885, as follows:

Year.	Cents.	Year.	Cents.
1873	2.45	1879	1.58
1874	2.51	1880	1.57
1875	2.10	1881	1.52
1876	1.73	1882	1.70
1877	1.95	1883	1.43
1878	1.74	1885	1.20

to improve the Minnesota River above Mankato, nor do the]
as I could learn.

As for the stretch of river between its mouth and Mankato,
ever be used for the transportation of general merchandise, such
furniture, etc., no matter how improved. It would be utilize
tion of crude articles, like cement, lime, brick, lumber, stone
view of the future development of the manufacturing interests
make an expenditure to ascertain definitely the best method a
igable this section of the stream.

Whatever method is adopted, the masonry foundations wil
sive, to withstand the floods that will submerge them. Sinc
Colonel Farquhar's surveys were made lands have become val
overflow, if slackwater is adopted, may form a large item of c
ments, bridges, trestles, highway bridges, and other works l
would more or less have to be considered in any plan of impr
believe it would be advisable, if any new estimates are made,
tirely new survey.

From consideration of all the facts that I have b
I am of opinion that the Minnesota River, from its
is worthy of improvement by the General Governı
practicability and cost of the same should be deter
vey, the cost of which and the preparation of maı
and estimates I place at $7,000.

With this report is a sketch showing most of th
posed railroad lines in northern Minnesota.

Very respectfully, your obedient servant,

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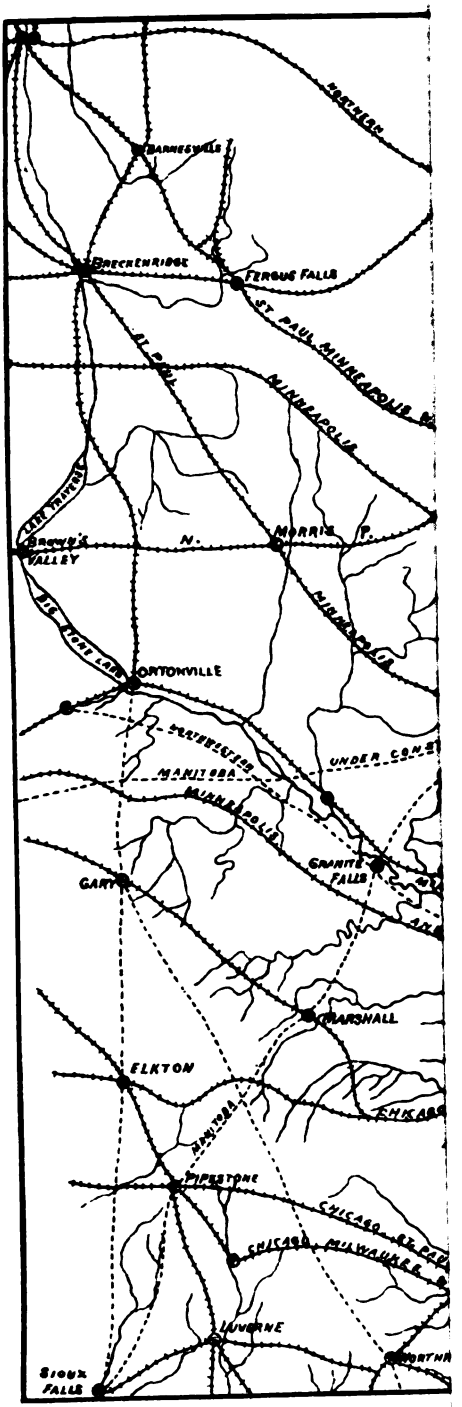
Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF MINNESOTA RIVER WITH A VIEW TO
BY LOCKS AND DAMS.



SKETCH SHOWING PRE
IN NORTHERN MINN

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of discharge, location of bars and bridges, and a carefully checked line of levels from south bend, 3.3 miles by river above Mankato, to the mouth of the river, a distance, measured along the channel, of 118.6 miles, and along the axis of the valley of 80 miles, the difference between the two measurements being due to the windings of the river. The line of levels was connected with the zero of the gauge on the pier of the Wabasha Street Bridge at Saint Paul. Elevations of the low-water surface were taken at intervals, and also those of reliable high-water marks of 1881, wherever they could be found, the flood of that year being the highest, within the limits of the survey, of which there was any record. The effect at Saint Paul of that flood is described in the report of the Chief of Engineers for 1881, Appendix W, part 2, pages 1754–1756.

Bench-marks were also established at convenient points for future reference. The stage of the river above Little Rapids during the time of the survey was the lowest of which there was any record. Below Little Rapids the stream is affected by the stage of the Mississippi, the Minnesota uniting with the Mississippi at Saint Paul. The stage of the stream, however, below Little Rapids was the lowest known, excepting the stage, perhaps, of August, 1886, a measurement taken at the mouth of the river about the middle of that month showing a volume of discharge of but 470 cubic feet per second. I personally examined the river at different points, in June, July, and August. The surveying party was in immediate charge of Mr. A. O. Powell, assistant engineer, to whom I am indebted for conscientious and valuable work in field and office. The amount of funds at command did not admit of making borings at the additional sites for locks and dams suggested during the survey, or of making drawings of plans for improvement. The Minnesota River is subject to heavy floods, followed by long periods of low water. The banks (bottom lands) are generally steep, rising from 10 to 20 feet above low-water surface, and composed of sand and alluvium, the former predominating as the stream is ascended and easily moved by the current. After floods the caving banks contribute trees in abundance, which eventually form snags, while the material from the banks adds to the bars, which, at low-water stage, render long stretches of the stream impassable to steamers. The snags are, at all stages, formidable obstructions to navigation. The width of the stream at low water, within the limits of the survey, averages 200 to 250 feet. At times of great floods the valley is submerged, more or less, from bluff to bluff, the average width between bluffs being about 1 mile. The bottom-lands bordering the river are generally timbered. The average low-water volume of the Minnesota, at its mouth, is 800 cubic feet per second. A gauging of the river at Mankato, July 10, 1887, gave 282.7 cubic feet per second. A gauging at Little Rapids, August 20, gave 309.6 cubic feet, and one at the mouth, August 15, gave 502.7 cubic feet.

Following is a table of distances, slopes, and ruling depths at low water:

Locality.	Distance above mouth of river (foot of Pike Island).	Elevation of water-surface above that of mouth of river at low water and when Signal Service gauge at Saint Paul reads 1.5.	Ruling depth between each locality and the preceding one at low water.	Difference in elevation between high and low water.	Low-water volume (1887).
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Cubic feet per second.*
Foot of Pike Island	0.	.....	.....	.....	.....
Railroad bridge between Fort Snelling and Mendota	1.7	0.675	2.0	.....	502.7
Credit River Bar	12.3	0.915	6.8	.....	.....
On Credit River Bar	.....	.....	3.0	.....	.....
Shakopee	25.9	1.152	5.0	.....	.....
Chaska	30.3	1.315	2.5	.....	.....
Carver	32.7	* { 1.507 2.974 }	2.5	26.660	.....
On Carver Bar	.....	.....	0.9	.....	.....
Little Rapids †	36.9	* { 3.059 4.915 }	2.3	.....	309.6
Jordan Ferry	41.2	5.095	3.0	.....	.....
Bevin's Creek	42.8	5.155	1.7	.....	.....
Belle Plaine	51.7	9.072	1.0	.....	.....
Blakely	59.6	12.939	0.9	.....	.....
Henderson	72.6	22.515	0.9	26.7	.....
Le Sueur	81.5	28.315	0.7	.....	.....
Ottawa	89.9	35.415	0.7	.....	.....
Saint Peter	97.2	42.908	0.5	23.6	.....
Mankato	115.3	64.815	0.6	24.9	282.7
Mouth of Blue Earth River	117.1	69.496	0.75	.....	.....
South Bend	118.6	69.515	3.2	.....	.....

* The difference between these elevations is the fall over the obstruction.

† During low water the river at Little Rapids abruptly falls 1.856 feet over a ledge of hard sand-rock, forming a complete obstruction to steam-boats.

Table of existing bridges all with draw-spans.

No.	Name of bridge.	Location.	Elevation of bottom chord above low water.	Range between high and low water.	Clear width of draw at low water.
			Feet.	*Feet.*	*Feet.*
1	Chicago, Milwaukee and Saint Paul Railway	Fort Snelling	27.4	.....	102.6
2	Shakopee Highway	Shakopee	27.75	.....	87.25
3	Chicago, Milwaukee and Saint Paul Railway	Between Shakopee and Chaska.	35.5	.....	98.25
4	Minneapolis and Saint Louis Railway	Carver	32.5	24.7	114.5
5	Belle Plaine Highway	Belle Plaine	34.5	.....	109.0
6	Henderson Highway	Henderson	26.5	26.7	123.0
7	Le Sueur Highway	Le Sueur	29.0	.....	97.0
8	Saint Peter Highway	Saint Peter	28.5	.....	113.0
9	Chicago and Northwestern Railway	do	36.75	23.6	100.0
10	Mankato Highway	Mankato	26.5	25.0	83.0

A report of a preliminary examination of the Minnesota River was made in 1867, by General G. K. Warren, in which the cost of an improvement to secure 4 feet of depth from the mouth to the Yellow Medicine, 121.7 miles above Mankato, by means of locks and dams, was estimated at $775,000. A very full report upon the physical features of the valley was also made by the same officers in 1874. It is printed in the Annual Report of the Chief of Engineers for 1875, Part I, pages 381–416.

In this report, General Warren largely increased the estimate of probable cost of improvement from Little Rapids to the mouth of the river over the estimate for the same in 1867. The report was adverse to the building of locks and dams in the bed of the stream, for the reason that the bed would be apt to fill up more or less, and the locks (unless provided with enormously high walls and guard-gates) also silt up more or less during heavy floods. The report suggested a preference for a canal, if an improvement were undertaken, though it would prove the more costly of the two methods. A survey in detail of the river, from its mouth to South Bend, was made in 1874 by Colonel Farquhar, from which to ascertain the feasibility and cost of improvement, either by means of locks and dams in the bed of the stream or by means of a canal with locks. The report of this survey was rendered February 11, 1875. This report recommended the building of five locks and dams in the bed of the river, the lower lock and dam to be located at Little Rapids and the others between that point and Mankato, at a probable cost of $699,283.53 and the removal of snags, bringing the entire estimated cost up to $733,868.63. The cost of a canal along the valley from the Rapids to South Bend would be, as the report stated, not less than two and one-half times that of the locks and dams proposed for the bed of the stream. The details of the estimates are given on pages 362–364, Report of the Chief of Engineers for 1875, Part I. The lock-walls not to extend above medium high water, as any deposit in the locks during extreme high water could, it was believed, be easily removed on the subsidence of the freshets by sluicing or scraping. The objections urged by General Warren against permanent dams in the river were recognized as well taken, but it was believed that the difficulties referred to could be overcome by the use of movable dams, which could be easily removed (lowered) on any sudden rise of the river, and replaced as soon as the river subsided below the 4-foot stage. The successful operation of movable dams upon rivers in France, for many years past, and in our own country of late years, places the question of their utility beyond dispute; and, if it is the intention to permanently improve the navigation of the Minnesota River, they promise better, in my spinion, than any other method proposed, a canal excepted, but which would prove very expensive.

The apprehension of increasing the heights of floods by the establishment of permanent dams in the bed of the stream is done away with by the employment of movable dams. Upon the lowering of the dam the area of cross-section of the stream for the passage of flood-water will be but a little less than the area before building the lock, while freshets will probably wash out any deposits of sand or other material made while the dam is raised. The location of the first, or lower, lock and dam recommended in the Report of 1875 was, as stated, at Little Rapids. But at such a stage of water as existed below the rapids during the survey of 1887 (about 3.940 feet lower than the stage of 1874), boats drawing 3 to 4 feet could not cross the bars between

Removal of 407,500 cubic yards of material from the bars, at 25
age) per cubic yard.....
Construction of 4,200 linear feet of wing-dams, at $5 per linear

Total.....

There are deposits of slabs and edgings in the be
tween Pike Island and the main shore which have floa
saw-mills at Minneapolis, and probably also from poi
sippi above that place, and been carried into the M
the channel between the head of Pike Island and Fo
current sets through this channel according to the
water in the two rivers. Average width of this chan
dredging would prove an unsatisfactory method of in
count of the liability of the dredged channels to fill
In addition, it would lower the surface of the reach at
sitating an increased lift of lock of several feet at Lit

(2) A lock and movable dam of about 7 feet of lif
stage, at the mouth of the river, near the foot of Pike
the bars and afford 4 feet of depth to Little Rapids, a
including that of a dam to close the channel betwee
Fort Snelling, of $250,000. This latter plan (No. 2) c
my judgment as in every way better than plan No. 1.
1 is only inserted here in order to show that it has
It is *not* recommended. The results of the recent sur
use of a greater number of locks and dams, and of g
than were estimated in the report of 1875, in order to
of overflow of lands to be caused by the dams while r
lessen the chances, if any, of deleterious effects from
ber, brush, etc., as the small volume of discharge of
water stages will cause the pools above the dams to l
at times. Following is a table showing the location,
(revised) of construction of and probable land dam
locks of masonry and movable dams recommended in
to afford a 4 foot variation at low water; the loc

	Locations.	Distance from mouth of river.	Lift.	Estimated cost.	Approximate land damages. Overflowed. Acres.	Overflowed. Value.	Injured. Acres.	Injured. Value.	Total approximate cost of land damages.	Total estimated cost of locks and dams and damages.
		Miles.	*Feet.*							
1	Little Rapids. See sheet No. 2	36.9	13.8	$212,160	1,400	$35,000	1,800	$27,000	$62,000	$274,160
2	⊡ 269. See sheet No. 3, 5.1 miles below Henderson	67.5	14.1	211,250	630	15,750	760	11,400	27,150	238,400
3	⊡ 240. See sheet No. 4, 4.6 miles above Le Sueur	86.1	11.6	188,050	265	6,625	820	12,300	18,925	206,975
4	⊡ 150. See sheet No. 5, 1.3 miles above Saint Peter	98.5	12.0	189,250	600	15,000	200	3,000	18,000	207,250
5	⊡ 85. See sheet No. 6, 6.2 miles below Mankato	109.1	9.0	170,350	210	5,250	310	4,650	9,900	180,250
	Total			971,060	3,105	77,625	3,890	58,350	135,975	1,107,035
	Add estimated cost of proposed lock and dam at the mouth of the river, and dam to close the Fort Snelling channel									250,000
										1,357,035
	Add for contingencies 10 per cent									135,703
	Total									1,492,738

Following is a table showing the location, lift, estimated cost of construction of, and probable land damages from the ten locks of masonry and movable dams suggested by the survey of 1887 to afford a 4-foot navigation at low water; the locks to be of the same horizontal dimensions and walls of same height as those in the preceding table, lock No. 1 excepted; the walls of which are to be carried to a height of 5 feet above the surface of pool to be created by the dam.

No.	Locality.	Distance from mouth of river.	Lift in feet.	Estimated cost.	Approximate land damages. No. of acres.	Approximate land damages. Value.	Total estimated cost of locks and dams and damages.
		Miles.					
1	At mouth		7.0	$250,000			$250,000
2	Little Rapids	36.9	6.0	149,500	370	$7,400	156,900
3	3.2 miles above Belle Plains*	54.9	8.3	156,400	74	1,480	157,880
4	5.1 miles below Henderson*	67.5	5.9	144,400	550	11,000	155,400
5	2.7 miles above Henderson*	75.3	8.0	153,800			153,800
6	4.6 miles above Le Sueur*	86.1	7.6	152,800	320	6,400	159,200
7	2.9 miles below Saint Peter*	94.3	7.0	153,300	780	15,600	168,900
8	4.6 miles above Saint Peter*	101.8	6.5	151,400	500	10,000	161,400
9	8.1 miles below Mankato*	107.2	7.5	155,400	670	13,400	168,800
10	3.1 miles below Mankato	112.2	6.0	146,600	100	2,000	148,600
	Total			1,613,600		67,280	1,680,880
	Add for contingencies 10 per cent						168,088
	Total						1,848,968

* See profile sheets.

In computing land damages all lands are considered as affected by overflow where their surfaces are 4 feet or less above the water-surfaces of the pools to be produced by the dams. The ascertaining of land damages is, at best, an unsatisfactory undertaking, unless in the form of condemnation proceedings.

Previous reports upon this river have not, so far as I know of, dealt with this subject. But at the *time those* reports were made land in

the valley of the Minnesota had not attained the value that is now set upon it. Before any work looking to an improvement by slackwater is undertaken, a full topographical survey should be made of the valley within the limits of the contemplated improvement, and all damages to accrue from the work appraised and paid for. A lock and dam of 7 feet of lift at the mouth of the river would flow out Little Rapids and carry a 4-foot navigation up to Jordan Ferry, 41.2 miles above the mouth, provided the ledge of rock at the rapids were excavated to a depth of 2.3 feet. But this would require a lock at or near Jordan Ferry; in fact, it would not reduce the number of locks required to assure navigation, at low-water stage, to Mankato, and the result of locating a lock and dam at the ferry, instead of at the rapids, would be to select a location with an uncertain foundation instead of one with a ledge of rock to build upon.

There may be seasons of navigation when the stage of water will be such that it will not be necessary to make use of some of the locks. In that case, the wickets forming the dams need not be raised. In arriving at the lifts of dams necessary, the swell or backwater to be produced by them has not been considered. It will not, probably, materially affect the estimates here given. The objection to low lock-walls is that the lock-chambers may silt up more or less during floods, and that, as the floods subside, drift-wood may lodge on top of the walls and gates. The silt may be disposed of by suitable provision for flushing the lock-chambers, and the drift be warded off by floating booms. Some slight dredging in the pools and in the lock-bays may be required occasionally. The cost of the foregoing accessories was considered in adding the item of 10 per cent. for contingencies.

RECAPITULATION OF ESTIMATES.

Approximate cost of 6 masonry locks and movable dams, of lifts ranging from 7 to 14.1 feet, including land damages	$1,492,738
Add for removal of snags	35,000
Total	1,527,738
Approximate cost of 10 masonry locks and movable dams, of lifts ranging from 5.9 to 8.3 feet, including land damages	1,848,968
Add for removal of snags	35,000
Total	1,883,968

In case a slackwater improvement should be undertaken, the first lock and dam of the system should be built at the mouth of the river, and their construction should precede any work for removal of snags. Large numbers of snags and bowlders and some rock were removed between 1867 and 1879 from the channels of the Minnesota River below the Yellow Medicine, at a total cost of $107,500,* the greater part of the work having been done below Mankato. But snags formed again after floods, forming obstructions which, added to the difficulties presented by several seasons of low water, were sufficient to divert steamers from the river had there been no other cause to force them off. Prior to the advent of railroads in the valley of the Minnesota the towns and counties adjacent to the river received nearly all their supplies and shipped their products by boat. It is reported that, in 1859, 103 steamboats arrived at Mankato from Saint Paul, and 29 from points above Mankato. In 1867, when the railroad was under construction from Saint Paul to points in the Minnesota Valley, steam-boats ran regularly from the terminal point of the road to river towns above, 90 trips being

*In addition to this amount the sum of $10,000 was expended upon the survey in 1874, from the mouth to South Bend.

made by one steamer alone. Upon completion of the railroad to Mankato, in 1868, most of the steam-boats were taken off the river below that place. In those days steamers navigated the river with difficulty at low-water stages, and even at times of high water snags presented great obstruction to navigation. But the freighting business was profitable even then. During the past season a small light-draught steamer navigated the river between Saint Paul and Little Rapids, principally engaged in carrying wood. Those who favor the improvement of the river claim that, were a 4-foot depth assured throughout the season of navigation between Saint Paul and Mankato, a class of medium-size boats with barges would be immediately placed upon the river, upon which the products of the valley would be transported at reduced freight rates to result from competition with the railroads, and that, generally, an improved river would regulate freight rates during the greater part of the year. Mr. S. F. Barney, chairman of the Mankato Board of Trade committee on Minnesota River improvement, estimates that about $3,500,000 worth of the products would be shipped by river were it made navigable, with a reduction of at least 20 per cent. in freight rates. On account of the difficulty in obtaining statistics of the commerce of the valley to be benefited by the proposed improvement, I append hereto copies of letters received, and marked as appendices A, B, C, D, E, as follows:

Copy of letter from S. F. Barney, chairman committee on Minnesota River improvement, dated October 3, 1887.

Copy of letter from W. H. Weibler, Belle Plaine, dated November 8, 1887.

Copy of letter from Henry J. Dane, postmaster, Le Sueur, dated November 9, 1887.

Copy of letter dated November 16, 1887, from Charles Johnson, postmaster at Carver, Minn., and Messrs. Frank Warner, president of the village council, A. Knoblauch, banker, and A. G. Anderson, state senator.

Copy of letter dated December 19, 1888, from H. A. Miller, for the Board of Trade of Saint Peter, Minn.

The following are added in conformity to the requirements of section 2 of the river and harbor act of Congress, approved June 23, 1866:

The portion of river surveyed lies within the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which port the revenue collected for the fiscal year ending June 30, 1887, was $6,537.80.

The nearest Government buildings are: A custom-house and post-office building, also an Army building, at Saint Paul, and a post-office at Minneapolis.

Opposite the head of Pike Island is Fort Snelling.

With this report are eight tracings, six of them maps showing extent of flowage to be caused by the five dams projected in 1875, and two of them continuous profiles from South Bend to the mouth of the river.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A.

LETTER OF CHAIRMAN OF COMMITTEE ON MINNESOTA RIVER IMPROVEMENT, MANKATO BOARD OF TRADE.

MANKATO BOARD OF TRADE,
COMMITTEE ON MINNESOTA RIVER IMPROVEMENT,
Mankato, Minn., October 31, 1887.

MY DEAR SIR: Within you will find the result of my endeavors to ascertain the statistics sought in yours of 18th inst.

I by no means vouch for the correctness of the figures given. It has been extremely difficult to get any *figures from the counties* other than Blue Earth. Mankato has

Agricultural products for the year 1886 of the six counties bordering River between its mouth and Mankato, not including Hennepin

Products.		Quantity.	Products.
Wheat	bushels	4,360,007	Sugar-cane (sirup)
Oats	do	2,721,315	Cultivated hay
Corn	do	2,308,666	Wild hay
Barley	do	208,418	Flaxseed
Rye	do	21,587	Butter
Buckwheat	do	3,095	Wool
Potatoes	do	542,192	

The six counties bordering on the Minnesota River between its mouth a cluding Hennepin and Dakota.

Name of county.	Amount of land in each county.	N
	Acres.	
Blue Earth	475,582	
Carver	226,652	
Le Sueur	284,496	
Nicollet	278,882	
Scott	219,344	
Sibley	362,808	
Total	1,847,764	

1. Commerce of the river prior to the advent of railroads in its va

It has been very difficult to arrive at the commerce of the river ing of railroads. I have been aided somewhat by statistics taken the "Mankato Board of Trade Reports," which has assisted in es river towns. All the estimates are confined to the river below Ma ing Hennepin and Dakota counties.

The amount shipped out (annually) ..... por
The amount shipped in (annually) .....

In 1869, the first season after the first railroad was complete steamer *Otter* ran between Mankato and New Ulm; carried from Ma 1,030,000 pounds of merchandise, 110,000 feet of lumber, and brou to Mankato 35,000 bushels of wheat.

2. Present commerce of the river:

It is estimated that 50 per cent. would be carried by river, and reduction in freight rates at least 20 per cent. With cheap and easy transportation our stone, lime, clay, and cement industries would be greatly increased.

B.

LETTER OF MR. WILLIAM H. WEIBLER.

BOROUGH OF BELLE PLAINE, MINN., *November* 8, 1887.

DEAR SIR: In reply to yours:

1. Prior to the advent of railroads in the Minnesota valley commerce was carried on principally through the Minnesota River, myself and family and many others coming to this place as early as 1854, and per steam-boat. Navigation of the river did not close that year until middle of November.

2. The present commerce of the river is much neglected, and only consists of brick and lime and salt, oil and cord-wood, the greatest obstacle being the Little Rapids, at or near Carver, in Carver County.

3. The value of the annual products and manufactures of the valley is certainly immense, as it is the garden of Minnesota, and is thickly settled. *Vide* State statistics.

4. The annual shipments of products, etc., at this place last year, as per railroad estimates of freight tonnage, is 25,500,720 pounds. Earnings, $26,176.80. There would be very little (if any) of the above but would be transported by water if navigation were in existence and railroad rates unchanged. And we do expect that the reduction in freight from this point would be at least one-half or one-third, leaving this place a clear gainer of some $15,000 or $20,000 a year.

Respectfully, yours,

WILLIAM H. WEIBLER.
Pr. WILLIAM HENRY,
Attorney at Law and Fact;
also for Borough of Belle Plaine.

Maj. CHARLES J. ALLEN, U. S. A.

C.

LETTER OF MR. HENRY J. DANE.

LE SUEUR, *November* 9, 1887.

SIR: Yours of November 4 received in due season. In reply, would say as to No. 1, commerce of the river prior to the advent of railroads in the valley, I could not give any thing reliable.

As to question No. 2, would say as to present commerce, there is none, and there has been none for a good many years to speak of.

Question No. 3: Value of annual products and manufactures of the valley, I could not give any estimate that would be reliable.

Question No. 4: Annual shipments of products, etc.; there were shipped from this point in the past year and will average for the last three years—

	Tons.
400,000 bushels wheat and flour	= 12,000
4,000 cords wood	= 6,000
1,200,000 pounds pork	= 6,000
Butter and eggs	= 80
Receipts—	
Merchandise	1,500
Salt	150
Coal	300

Respectfully,

HENRY J. DANE, P. M.,
Le Sueur, Minn.

Maj. CHAS. J. ALLEN,
Major of Engineers.

D.

LETTER OF MR. CHARLES JOHNSON AND OTHERS.

CARVER, MINN., *November* 16, 1887.

SIR: In response to your letter of November 4, the undersigned most respectfully submit to you such information as is deemed reliable from own observations for the last thirty years' residence in the Minnesota valley.

Your first question being: Commerce of the river prior to the advent of railroads in its valley?

For years there were several steam-boats and barges doing business on the river. In the year 1868 there were seven steam-boats plying their regular trips, with at least two barges to each. These boats carried out and brought in all freight, and the commerce of the river amounted to at least $80,000 for the year.

2. Present commerce of the river?

None whatever.

3. Value of annual products and manufactures of the valley.

We can not estimate, but will say, low at $1,000,000.

4. Annual shipments of products, etc., and what proportion of the same would be transported by water were navigation assured from Mankato to the Mississippi River. And what reduction in freight rates might be expected as the result of an improved river.

Heavy freight, one-half.

Respectfully,

CHARLES JOHNSON,
Postmaster.
FRANK WARNER,
President of the Village Council of the Village of Carver.
A. KNOBLAUCH,
Banker.
A. G. ANDERSON,
State Senator.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

E.

LETTER OF MR. H. A. MILLER.

SECRETARY'S OFFICE, BOARD OF TRADE,
Saint Peter, Minn., December 19, 1887.

SIR: In answer to your favor of the 4th of November, 1887, I am directed by the Board of Trade of this city to inform you that, in their opinion, no great amount of products would be shipped by water were navigation assured, and, inasmuch as the season of navigation would be short, the reduction in freight rates would be of little consequence.

Number of pounds of freight received on the Saint Paul, Minneapolis and Omaha line for the last twelve months, 8,522,973; shipped during the same period, 18,157,586.

Respectfully,

H. A. MILLER.

Maj. CHAS. J. ALLEN.

Z 15.

PRELIMINARY EXAMINATION OF RED RIVER OF THE NORTH, MINNESOTA, FROM MOORHEAD TO FERGUS FALLS.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., December 3, 1886.

GENERAL: I have the honor to report as follows upon the preliminary examination of the Red River of the North from Moorhead to Fergus Falls, Minn., made in accordance with the requirements of sections 6 and 7 of the river and harbor act of Congress, approved August 5, *1886.*

Fergus Falls is on the Otter Tail River, and about 70 miles, by water, above its mouth. The Otter Tail and the Bois de Sioux River, which has its rise in Lac Travers, unite at Breckenridge, forming the Red River of the North. Moorhead is about 40 miles north of Breckenridge by land, and 101 miles distant from it by the channel of the Red River. The Red River between Moorhead and Breckenridge was thoroughly surveyed in 1874, and its improvement is included in the project for the general improvement of the river from Breckenridge to the northern boundary line. The plan for improvement of this section contemplates the removal of snags, bowlders, and leaning timber, and the contraction of the low-water way upon the 13 miles of river just below (north of) Breckenridge by means of brush wing-dams. During the winter of 1879–'80 a force of men removed large numbers of snags and leaning trees between Moorhead and McCauleyville, the latter named about 75 miles above Moorhead, thus improving this part of the river for high-water navigation. With this exception no work of improvement has been undertaken south of Moorhead.

For about 10 miles below Fergus Falls the Otter Tail River is full of bowlders, the descent is sharp, and a number of small rapids occur. In the next 10 miles the slope reduces, although the current is rapid, and the bed of the stream is obstructed by large quantities of bowlders. During high-water stages small flat-boats with light loads have run down this 10-mile section, but at great risk. The remainder of the river to Breckenridge, about 50 miles in distance, is comparatively sluggish, with depth of about 3 feet and average width of 70 feet at ordinarily low-water stage. In former years, steam-boats of fair size have navigated this section of the stream during high stages of water, and numbers of flat-boats laden with flour, coal, lumber, etc., were run from the upper end of this section to Pembina and other points on the Red River. This navigation appears, however, to have been discontinued during the past three years.

To render the first 20 miles of the Otter Tail River below Fergus Falls navigable, locks and dams would have to be resorted to at an expense apparently entirely out of proportion to the demands of navigation or to any public benefit to be derived from such improvement. The improvement of the Red River of the North from Moorhead to Breckenridge will practically open navigation from the former to within 20 miles of Fergus Falls, and this can be accomplished by means of liberal appropriations for improving the Red River of the North. While, therefore, the Red River from Moorhead to Breckenridge is well worthy of improvement by the General Government, no further survey of the route is required.

STATISTICS.

Under this head Assistant Engineer R. Davenport, who examined the route in November, reports:

The country south of Moorhead, naturally tributary to the Red River, is rapidly increasing in population, and the area cultivated is each year being largely extended. Within the last three or four years the facilities for moving the crops, etc., by rail have been considerably increased, but the rates are still exceedingly high, nearly three to one as compared with some other localities in Minnesota. The improvement of the Red River, as yet not continuous, can now only be said to be of local benefit, though the completion of the improvement of the Red River from Breckenridge to the boundary-line can not fail to be of great general benefit to that entire section of country.

Of the country immediately tributary to the river between Fergus Falls and Moorhead the following statistical information was collected:

Town of Fergus Falls, population 4,285. Population of Otter Tail County, 33,000. Total acreage in county, 1,270,977 acres. Area cultivated, 152,600 acres. Hay lands, 40,000 acres. The wheat crop of 1886 is estimated at 1,775,537 bushels; oats at 939,061 bushels.

In the limits of Fergus Falls there are five dams for water-power, with heads from 7 feet to 17 feet—a combined head of 64 feet. The manufactories consist of five flour-mills, with a total capacity of 1,525 barrels of flour per day; one 10-ton paper-mill; sash, door, and blind factories, etc.

Breckenridge has a population of 700. Population of Wilkin County, 4,000. Total acreage in county, 476,387. Acreage cultivated, about 75,000. Hay lands, about 10,000. Wheat crop estimated at 1,000,000 bushels. Oats, barley, etc., about 400,000.

Wahpeton, population 2,200. Richmond County, population 11,000. Estimated acreage of county, 836,950. Acreage cultivated, 150,000. Wheat crop estimated at 1,500,000 bushels. Oats, barley, etc., 250,000 bushels. Wahpeton has one flour-mill of 100 barrels daily capacity.

Fargo has a population of 8,206. Population of Cass County, 21,085. Acreage in county, 911,795. Acreage cultivated, about 425,000. Wheat crop estimated at 5,554,845 bushels. Oats, barley, etc., 1,166,550 bushels.

Population of Moorhead, 3,500. Population of Clay County, 10,500. Acreage cultivated, 96,087. Wheat crop estimated at 1,000,000 bushels. Oats, barley, etc., 500,000 bushels.

It was found very difficult to obtain reliable statistical information, and comparative statistics, showing the annual increase, etc., were out of the question. All the information possible was, however, obtained from the most reliable sources, and will serve to show the great advance in a locality that fifteen years ago was an actual wilderness.

The country south of Moorhead, in the vicinity of the Red River, is mostly level prairie, and, with the exception of narrow belts of timber along the river bottom, perfectly open.

Very respectfully, your obedient servant,

CHARLES J. ALLEN,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

EXAMINATION OF RED RIVER OF THE NORTH, MINNESOTA, FROM MOORHEAD TO FERGUS FALLS.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., November 25, 1887.

SIR: I have the honor to report as follows upon the examination of the Red River of the North from Moorhead to Fergus Falls, Minn., made in accordance with sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

My report of the preliminary examination of this locality, dated December 3, 1886, and to which reference is here respectfully made, contained the following statement:

To render the first 20 miles of the Otter Tail River below Fergus Falls navigable, locks and dams would have to be resorted to, at an expense apparently entirely out of proportion to the demands of navigation or to any public benefit to be derived from such improvement. The improvement of the Red River of the North from Moorhead to Breckenridge will practically open navigation from the former to within 20 miles of Fergus Falls, and this can be accomplished by means of liberal appropriations for improving the Red River of the North. While, therefore, the Red River from Moorhead to Breckenridge is well worthy of improvement by the General Government no further survey of the route is required.

The Otter Tail River unites with the Bois des Sioux River at Breckenridge, the two forming the Red River of the North. Fergus Falls is situated on the Otter Tail, about 70 miles above its mouth. The Otter Tail is closed to boats by two low bridges crossing it at a point about 2 miles above its mouth. One of them is a railroad bridge, the other a

highway bridge. Before small steamers can ascend this river these bridges must be provided with draws.

The Red River of the North was thoroughly examined by Major Farquhar in 1874, from Breckenridge to Moorhead, a distance of 101 miles by river, and its improvement is included in the project for the general improvement of the river from Breckenridge to the northern boundary-line. The report and maps of this examination were submitted to the Department February 8, 1875. The plan for improvement contemplates the removal of snags and bowlders from the channel and of leaning timber from the bends, and the deepening of the stream where bars occur by the construction of brush wing-dams, to concentrate the flow of water upon the bars.

During the winter of 1879–'80, a number of snags and leaning trees were removed between Moorhead and McCauleyville, the latter about 76 miles above Moorhead, thus improving this extent of river for navigation during high stages of water.

From the survey of 1874, and from personal examinations made last summer by myself and assistant, the following facts are obtained:

For a distance of 4 miles below Breckenridge there is a channel of about 4 feet depth and 100 feet width at ordinarily low water; thence for about 9 miles the channel is obstructed by islands, sand, and gravel bars and bowlders. The total fall of the stream for this distance of 13 miles is at low water about 17 feet, the greatest slope being at Connelly's Rapids, 13 miles below Breckenridge, where it is at the rate of 2½ feet per mile.

From the foot of the rapids to the mouth of the Upper Wild Rice River, a distance of 68 miles, the stream is for 7 miles obstructed by snags, leaning trees, and some bowlders. The low-water depth over this distance of 68 miles is, however, from 6 to 10 feet and the width about 95 feet, but the stream is very tortuous. Average slope, 0.72 foot per mile.

From the mouth of the Upper Wild Rice River to Moorhead, about 20 miles, the river has fewer obstructions, easier bends, and a ruling depth of 5 feet at ordinarily low water.

The estimate of cost of improvement, based upon the survey of 1874, was as follows:

For removing snags, bowlders, and leaning trees	$14,706.00
For brush-dams to improve the 13 miles of river below Breckenridge	5,897.62
	20,603.62
For contingencies, 10 per cent	2,060.36
Total	22,663.98

But the river is subject to heavy freshets, the extreme rise at Moorhead being 28 feet, and at Breckenridge 12 feet. The banks of the river are steep and subject to undermining, more or less, from the action of floods; as the banks cave they contribute sand and gravel, which go to form bars, and trees which add to the number of snags, so that, notwithstanding the obstructions removed in the winter of 1879 and 1880 between Moorhead and McCauleyville, there are a number still requiring removal and for which the estimate of 1874 is not by any means too large.

The survey of 1874 was made when the river was at a stage somewhat above ordinarily low water; consequently the number and extent of obstructions at extreme low water were not then known. Since 1874 the low-water volume at Moorhead has several times been but one-half

of what it was in that year, while in 1866 it was not, probably, more than one-fourth of the 1874 low-water volume. When the river volume falls as low as it did in 1886 no steam-boat navigation above Moorhead, even with contraction of its channels by wing-dams added to removal of obstructions, is practicable, and none should be expected. Locks and dams would doubtless secure navigation at such low stages, but their cost would be so out of proportion to the present public demand that it is not worth while to consider them in this report.

An open-river navigation for small steamers and barges or flats can be secured at ordinarily low-water stage from Moorhead to Breckenridge, by the removal of the obstructions named, by the construction of wing-dams, and by the use of a dredging machine for one season to remove some shoals from the foot of Connelly's Rapids as well as some shoals that narrow the channel a few miles south of Moorhead.

The cost of one season's dredging is placed at $9,000, which, added to that of wing-dams and removal of obstructions, brings the cost up to $31,663.88, all of which can be profitably expended in one year.

The Red River is crossed at a point about 5 miles, by land, below Breckenridge by the Saint Paul, Minneapolis and Manitoba Railway Bridge, constructed this past summer and fall. The bridge is of dimensions as follows: width of span, 150 feet; height of span above low water, 23 feet.

It is unprovided with a draw and no steamer can pass it, and improvement of the river at this point will be of no avail until the bridge is provided a draw of sufficient width.

COMMERCIAL STATISTICS OF THE RED RIVER OF THE NORTH FROM BRECKENRIDGE TO THE NORTHERN BOUNDARY-LINE.

Comparative statement of freight moved by steam-boats and barges for the past nine years.

Year.	Pounds.	Year.	Pounds.
1887	24, 918, 890	1882	63, 303, 6[illegible]
1886	21, 013, 657	1881	53, 114, 8[illegible]
1885	46, 085, 499	1880	43, 301, 5[illegible]
1884	58, 091, 476	1879	35, 718, 7[illegible]
1883	50, 627, 951		

The freight carried on the river between Moorhead and McCauleyville, a distance by river of about 76 miles, was mostly by one steamboat with barges, the average amount being about one-third of the total carried on the entire river. Wheat is the principal freight, though there are considerable shipments of merchandise, lumber, and wood.

The area of country tributary to the river south of Moorhead (between Moorhead and Breckenridge) contains about 825,000 acres, on which wheat is the principal product.

As will be noticed by the comparative table, the improvement of the river commenced in 1879, was followed by a steady increase in amount of freight carried to 1882, inclusive. The decrease since that year is mostly due to the steady decline in the stage of water caused by long-continued drought, and to some extent, undoubtedly, by the increase in the number of railroads traversing the country. In 1886, the year of lowest water of which there is any record, the precipitation south of Moorhead was about three-fifths of the average annual amount for that section.

During the past five years a number of small elevators, of capacities varying from 20,000 to 30,000 bushels, have been built along the river at points south of Moorhead for the purpose of receiving wheat to be moved by water. The continued low water and consequent prominence of snags, bowlders, and bars prevented the utilization of these elevators to the extent that would have obtained had the improvement of this section, commenced in the winter of 1879–'80, been carried to completion.

The Red River of the North is within the customs district of Minnesota, of which Saint Vincent is the chief port of entry. Collections for the year ending December 31, 1886, were $7,163.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX A A.

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Tennessee River.
2. French Broad River, Tennessee.
3. Little Tennessee River, Tennessee.
4. Hiawassee River, Tennessee.
5. Clinch River, Tennessee.
6. Duck River, Tennessee.
7. Cumberland River, Tennessee and Kentucky.
8. South Fork of Cumberland River, Kentucky.
9. Caney Fork River, Tennessee.

EXAMINATIONS AND SURVEY.

10. Obeil's [Obey's] River from the point where improvements have heretofore been made to the mouth of the West Fork, Tennessee.
11. Bear Creek, Mississippi and Alabama [Big Bear Creek, Mississippi and Alabama].

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., July 13, 1888.

SIR: I have the honor to transmit herewith the annual reports upon the river and harbor improvements in my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A A 1.

IMPROVEMENT OF TENNESSEE RIVER.

(Length, 650 miles.)

About 4½ miles above Knoxville the waters of the Holston and French Broad Rivers unite, thus forming the Tennessee River.

By the early French explorers this stream was known as the Rivière des Cheraquis, or Cherake, and in an Indian deed of cession to England, in 1767, it is called the Cherokee River. However, the chief town of the Cherokee Nation being at Tennassee, on the west bank of a

stream of the same name—the present Little Tennessee—which on joining the Holston, 47 miles below Knoxville, gave the name of Tennessee to the river and the State. Some geographers have formed the Tennessee by the junction of the Holston and Clinch, 32 miles below the mouth of the Little Tennessee.

By act of March 3, 1871, section 2, it is directed that certain funds "for the improvement of the Tennessee River," shall be expended between "Knoxville and Chattanooga," thus giving legislative sanction to extension of the Tennessee River to Knoxville; but as rivers are formed naturally by the confluence of their tributary waters, it is deemed advisable that appropriations for "improving the Tennessee River, above Chattanooga," should be held as applying to the 4 or 5 mile stretch of navigable waters to the mouth of the French Broad River; this 5 miles being the Holston River, now so called.

The Tennessee is an affluent of the Ohio, and ranks as one of the most important of the 45 or more navigable rivers tributary to the Mississippi.

It is navigable from its source to its mouth, excepting at the Muscle Shoals, in Alabama, where about 23 miles of obstructions form a complete barrier, except when the water is at its highest stage. This great obstruction will in a short time be overcome by the completion and opening of the Muscle Shoals Canal.

Other obstructions, some difficult and dangerous, require further examination and detailed plans for their removal or modification.

1. ABOVE CHATTANOOGA (194 MILES).

From the mouth of the French Broad River to Chattanooga the river is navigable for light-draught boats during the greater part of each year.

In 1830 Col. C. H. Long, U. S. Topographical Engineers, made an examination of the Holston and Tennessee rivers to the Tennessee and Alabama state-line. In 1871 a re-examination was made between Knoxville and Chattanooga.

These examinations show that the principal obstructions are rock reefs, sand, and gravel shoals. A few snags are found in the channel, formed by the heavy drift brought down by the annual floods, but the beds and banks of the Upper Tennessee are of such character as to make the improvement practically permanent.

The present plan of improvement is to blast a channel through the reefs, to excavate the sand and gravel-bars, and to build riprap dams to contract the waterway, so as to secure a safe navigable channel having a depth of about 3 feet at low water.

The snag and tow boat for use on this river and its tributaries, in process of construction at the close of the last fiscal year, was completed, and after a trip to the Muscle Shoals, towing dredge, etc., was moved up the river to Half-Moon Island Shoals, and employed in towing stone-barges, etc., repairing and extending dams at that obstruction. As a measure of economy in outlay for boats for "quarters" and moving stone, supervision, etc., active operations are carried on in connection with the work in progress on the tributaries of the Upper Tennessee.

In October, work on the French Broad being suspended, the working force moved down to Baker's Shoals of the Tennessee, and began the work of channel excavation, building riprap dams, and removing snags.

Operations were carried on also at Russell's Shoals and Caney Creek Shoals until December, when the available funds being nearly exhausted *the United States* snag and tow boat *Weitzel* and the fleet of boats, with *other engineer* property pertaining to the works, moved down to Chat-

tanooga for winter moorings, and were placed in charge of watchmen until new appropriations become available and operations are renewed.

Location.	Excavation, loose rock.	Quarrying.		Dams.		Snag-boats.			
		Riprap.	Stripping.	Spur riprap.	Length.	Snags removed.	Snags cut up.	Trees cut down.	Trees topped.
Half-Moon Island	.....	74	.....	181	.....	10	51	.....	.....
Caney Creek Shoals	.....	.....	.....	.....	.....	8	.....	.....	.....
Baker's Shoals	30	250	120	271	140	48	29	.....	.....
Russell's Shoals	.....	462	297	320	.....	61	.....	58	35
Total	30	788	417	772	140	127	80	58	35

The commerce of the Upper Tennessee is growing rapidly, and at present consists principally of logs, lumber, grain, iron ore, forage, live-stock, and general merchandise.

The accompanying commercial statistics are reliable, having been obtained from the boats' manifests, etc., by an employé on the river works, and are necessarily made up largely of the commerce reaching Chattanooga from the tributary streams.

The statistics by no means represent the entire commerce of the river, as very many rafts and laden flat-boats are disposed of at points en route, of which it is impracticable to obtain data.

The prospective advantages to navigation, as well as present benefits to the community, by completing the improvement of the Upper Tennessee, are the securing of an improved channel during a lengthened season of navigation, which by reason of the improving of its largest tributaries—French Broad and Clinch rivers—will extend to Leadvale (90 miles) on the former, and to Clinton (70 miles) on the latter, together with the practical enjoyment of the commercial advantages resultant from a navigable lower river to the great western waters by the completion and opening of the Muscle Shoals Canal to the commerce of the Mississippi system.

The amount available, if the pending river and harbor bill becomes a law, and the amount herein asked for, can be profitably expended in clearing the channel of snags and other surface obstructions from the mouth of the French Broad River to Chattanooga, and in channel excavation, building wing dams, etc., at Soddy Shoals, Kelly's Shoals, and other points, as provided by the existing project, after an examination shall have determined which of the obstructions now requiring immediate attention are the most serious obstacles to navigation.

Estimates for improving Tennessee River above Chattanooga, as modified and increased, from 1871 to 1874	$300,000.00
Amount appropriated	266,000.00
Amount expended	225,947.70

Money statement.

July 1, 1887, amount available		$5,274.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,177.49	
July 1, 1888, outstanding liabilities	45.11	
		5,222.60
July 1, 1888, balance available		52.30
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,052.30

Amount (estimated) required for completion of existing project.....	$59,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

II.—BELOW CHATTANOOGA (456 MILES).

In 1824 the then Secretary of War, John C. Calhoun, asserted that a canal around Muscle Shoals was of great national importance.

In May, 1828, Congress granted to the State of Alabama 400,000 acres of United States lands to be applied principally to improving the navigation of Muscle Shoals and Colbert Shoals. The United States Board of Internal Improvement submitted a project in 1830 for the construction of a canal from Brown's Ferry to Florence, and for the removal of obstructions from Florence to Waterloo.

The State of Alabama began work on the Muscle Shoals Canal in 1831, and it was opened in 1836, but was not built according to the project submitted by the above-named Board; it was used only a short time, having been practically abandoned the following year.

As stated in last annual report:

In 1867 an examination was made from Chattanooga, Tenn., to Paducah, Ky.

An instrumental survey of the three divisions of the entire chain of obstructions known as the Music Shoals was completed, and upon that the present project is based, modified, however, as to the character of work done at Little Music Shoals and as to the change of location of the canal from the north side to the south side of the river at Elk River Shoals.

The resurvey of the last-named division was made in 1877.

The Muscle Shoals extend from deep water at Brown's Ferry to deep water at Florence, a distance of 38 miles, only 8 miles of which were navigable.

From Chattanooga, Tenn., to Decatur, Ala., the section of river above the Muscle Shoals, there is much work to be done at several of the obstructions, especially at the "Suck" and the Bridgeport and Guntersville bars.

Below the Muscle Shoals, from Florence, Ala., to the mouth of the river, the principal obstructions are at Colbert Shoals and Duck River Shoals, though there are other obstacles of minor importance that require attention.

As the Muscle Shoals, the rocky barrier that effectually closes navigation, must necessarily be overcome before the river can be utilized to any great extent, it has been heretofore for this reason held advisable to press forward that work to completion before submitting any projects and revised estimates for the radical improvement of other portions of the channel, either above Decatur or below Florence.

The existing project, with estimates, is—

(1) To enlarge, rebuild, and straighten the old work at Big Muscle Shoals by constructing a canal 14½ miles long, having 9 locks with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, and having a depth of 5 feet of water on the miter-sills.

(2) To construct at Elk River Shoals a canal 1½ miles long, with 2 locks having lifts of 12 feet and from 5 feet to 9 feet respectively, and of same dimensions as the locks at the Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed-rock of the river, and to construct stone wing-dams and retaining-walls, to contract the water-way and to check the velocity of the current at certain points.

(4) To remove or reduce the worst obstructions above Decatur and below Florence to the limited extent that may be imperative to assist low-water navigation, having in view the submission of plans and revised estimates for a radical improvement of the various obstructions.

At Little Muscle Shoals the project is practically completed, at a cost of $126,180. A channel about 2½ miles long has been blasted out and about three miles of permanent stone dams built; but, as stated in the annual report for 1886, "the current is strong, and the velocity, combined with other causes, may require that further work be done on this section, either by the construction of locks," as originally provided for in the estimates, "or by a modification of the present system of dams."

At the Big Muscle Shoals.—C. A. Locke, assistant engineer, in local charge. The principal work done during the fiscal year consisted in

rock and earth excavation on sections No. 1 to No. 11, inclusive; and in the construction of the permanent dams at Bluewater Creek and Six-Mile Creek; in building the first of the drop gates needed for the five lower locks. Work was also continued upon the miter-gates of the several locks and upon the Shoal Creek Aqueduct; also upon the embankment at Lock No. 6, and the coffer-dam at Lock No. 9.

[Quantities given in cubic yards.]

Location.	Excavation.				Stone quarried.	Stone cut.		Masonry laid.			Dams.		Embankment.
	Solid rock.	Loose rock.	Sand and gravel.	Earth.		Cut stone.	Rock face.	Cut stone.	Rubble.	Dry rubble.	Riprap.	Coffer.	
Section No. 1	815			2,200									
Section No. 2	500			11,145									250
Section No. 3				560									
Section No. 4				3,500									
Section No. 5				510									
Section No. 6				1,525									
Section No. 7				5,979									
Section No. 8				4,270									550
Section No. 9				12,112									1,000
Section No. 10				1,425									140
Section No. 11	2,000	640		2,850						208		1,415	
Lock No. 5				550									
Lock No. 6													225
Lock No. 9												550	
Bluewater Dam			110	2,080	246	92	11	295	1,505			400	
Six-Mile Creek Dam								141	400		100		
Total	3,315	640	110	48,706	246	92	11	436	1,905	208	100	2,365	2,165

Some miscellaneous work was done, among which was the following at—

Lock 1.—Fitting and laying valve-tracks, placing lock-bridge, gear and spar brackets, etc.

Lock 2.—Placing hand-rails and spar-brackets.

Lock 3.—Placing valve-sills and valves, lock-bridge irons, hand-rails, and spar-brackets.

Lock 4.—Placing and notching valve-sills; placing lock-bridge irons.

Lock 5.—Constructed drop-gate which is finished and placed in position. (For plan and maneuvering-gear of this drop-gate, see Annual Report of Chief of Engineers; 1887, page 1742.)

Locks 5, 6, 7, 8, 9.—Quarrying and cutting stone for drop-gate wells; excavating for and placing anchors, anchor-bolts for straps; trestle supports, checking masonry for straps, fitting valves, etc., excavating drop-gate pits, built 400 feet of trestle, and laid 2,000 feet of track to Lock 9, fitting lock-bridge irons, etc.

Shoal Creek Aqueduct.—Drilling side plates; riveting side plates to angle-irons and beams; punching braces; completed the drilling of joints of side plates and sitting in of cap-screws; drilling holes for connecting straps of I beams; punching of side plates and riveting of bottom plates completed; checks cut on ends of piers for saddles and under bottom plates; and clearing rust from, and painting plates on, both sides.

While building the Blue Water Dam, during the present season, one span was added 44 feet long, to the eight previously provided for, making the length of the river at the mouth of Bluewater Creek 396 feet.

Necessary work was done constructing the Douglass Branch Bridge, and in clearing the dams and aqueduct of drift and deposit brought down by the heavy floods of March.

During the night of March 25 occurred the most severe and destruct-

ive rain-storm ever known in northern Alabama, the effect of which upon the Muscle Shoals Canal was as follows:

The damage was due solely to the rapid fall of rain, the river at the time being low and the canal practically empty. The rain began falling just before night, and it is thought that at midnight the canal trunk was full throughout its entire length.

An inspection of the canal, made as soon as practicable after the occurrence of the storm, shows that the damage was comparatively small, though the entire work was most severely tried in many ways, and may be summed up as three breaks in the tow-path, each about 100 feet in length; a washout back of Lock 6, at which point about 5,000 cubic yards of material was carried away and deposited in the canal just below the lock; a large accumulation of drift in and about several of the locks and against the dams and aqueduct piers, and slight washings of the tow-path on the outside at a number of places where the flood passed over.

No damage was done to the masonry of the locks or the aqueduct piers, and the aqueduct was not injured, though the water swept through it with great force.

Shoal Creek rose to within 2 feet of the floor of the aqueduct, and brought down a large quantity of drift, much of it being large logs, which, owing to the low stage of the river, had just sufficient space to pass beneath the bottom of the aqueduct without damage. Had the river been a few feet higher, these heavy logs might have broken the thin side-plates of the structure. Much drift was left piled against the piers.

The three breaks above mentioned can be repaired at small cost. The railroad track has been replaced on trestles over them, and as soon as funds become available the openings can be filled with the aid of the locomotives and dump-cars in a very short time. No additional damage is likely to follow, as the breaks occurred at points where the canal was at a considerable distance from the river.

The effect of this storm proves conclusively that the present plan of the channel provides an insufficient means of escape for flood water during heavy rains, and additional weirs must be added.

The building of the dredge-boat *Harwood*, which was in progress at the close of the last fiscal year, has been completed, together with its two attendant dump-scows, and were taken to the Elk River Shoals. The United States steamer *Weitzel* was also completed this year for service upon this river and its tributaries.

The dredge will be employed principally in dredging the channel entrance to the canal and in keeping the entire prism clear of obstructions, and of the required depth.

The pending river and harbor bill, if it become a law, as passed by the Senate, contains ample provision for the acquiring of "the land needed for the sites of the permanent buildings necessary in the management of the canals at the improved shoals."

Surveys on the Muscle Shoals Canal have already been made for the purpose of determining suitable sites for these buildings; and also for ascertaining, as a matter of record, the amount of "overflowed lands," and lands "cut off" by the canal from the mainland when the Muscle Shoals Canal is in operation.

At Elk River Shoals.—William A. Barlow, assistant engineer in local charge. The available funds being nearly exhausted, only a small force could be employed in the excavation of canal-trunk and for foundation of dry walls, laying masonary of dry walls, repairing dams, removing

drift, etc., and in the work pertaining to the placing of valves, gates, maneuvering-gears, etc.

Location.	Excavation.		Quarrying.		Masonry, dry wall.	Dams.	Snags removed.
	Sand and gravel.	Earth.	Riprap.	Stripping.			
	Cubic yds.	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Number.*
Canal trunk	953	2,255			288		
Milton's Bluff			2,641	400			
Dam repairing						4,219	
Snags, drift, etc							650
Total	953	2,255	2,641	400	288	4,219	650

Much miscellaneous work was done on this division: Drilling holes in miter-sills of locks, leading miter-bolts, placing wickets (Lock B), constructing lock-bridges, rebuilding old wall above Lock A, building slope wall below Lock A, and above and below Lock B, grading and relaying railroad track on the north side, and resloping south side of canal, dredging channel below Lock B, repairing ditch above Lock B, painting lock-gates, moving timber, beams, etc., from Decatur to head of Muscle Shoals, in tow of steamer *Elk*, etc.

The canal and locks of this division were so far completed as to be tested by actual use in passing the dredge, and in moving the boats laden with materials for the lower division, but unfortunately a break about 100 feet long was made in the embankment, above Lock A, on January 4 last.

The part of the embankment where the break occurred, though not finished, had been in position several years, and was believed to be perfectly secure. A cross-dam just above it had been opened two months previous to the accident, to give access to the locks, and the embankment had sustained a good head of water, without sign of weakness. An examination of the bank at the break showed that the material of the embankment was principally of light loam, which, when saturated by the rising river outside, became much weakened and was unable to resist the increased pressure due to the rise inside. This bank and its interior dry slope revetment was swept away.

The water has remained too high, even if funds were available, to do the work of repair economically.

No further widening of the break is likely to occur, as the lock abutment forms a protection at one end, and the riprap dam at the other end.

In fact, the violent floods of the following March, above referred to, did not increase the damage. The substantial stone dam will be extended to the lock-wall before the opening of the canal to general navigation.

The dam extending from the head of Lock A to foot of Brown's Island, 2½ miles in length, was repaired along its middle and upper sections by relaying portions which had been injured by drift, and by filling holes below the surface, which allowed the escape of water, thus adding somewhat to the height of the pool.

Above this pool in Brown's Island Chute the present channel is very unsatisfactory, being crooked, crossing the chute to the island, and then back to the main shore just above the dam. In this place the current at ordinary stages makes a serious draw over the dam, rendering navi-

gation both difficult and dangerous; even the local pilot on the work having trouble in following it with the small Government tow boat.

With a view to suggesting a remedy for this defective channel, a survey of the locality was made by First Lieut. H. E. Waterman in November.

From the soundings shown by this survey it was found that to change the channel so as to avoid the dangerous vicinity of the dam and carry it along the main shore almost in an exact straight line, giving a depth of 5 feet and a width of 100 feet, will require rock excavation to the amount of about 28,000 cubic yards.

The present channel has never been completed, though considerable excavation has been done, a great part of which would not be abandoned by the change proposed, as a considerable section extends along the main shore in the line of which the proposed work would form an extension, the crooked part above referred to being left out.

It is believed that this modification is one that will be demanded as soon as navigation on this part of the river is attempted, and therefore it would be advisable to anticipate this demand by doing the work as early as practicable.

Lock A, at the head of the Elk River division of the canal, is provided with an upper bay, the walls of which are 5 feet higher than those of the lock chamber. It was the intention to build the dam above, about on a level with the top of chamber walls, the additional height of the upper bay and gates serving as a guard to the lock.

The dam as built is really higher than the chamber walls and lower gates, and when made tight, as it should be, to afford sufficient depth above, the pool will stand at a higher level than the top of the chamber walls, interrupting the use of the lock. It is believed that this entire lock should be raised to the level of the upper bay, and a waste-weir provided in the dam at a suitable place above the lock.

A survey (10.1 miles) of the Colbert Shoals and Bee Tree Shoals was completed in December, 1887, and report rendered in January, 1888.

The head of these obstructions is about 21 miles below the Muscle Shoals, and their radical improvement is obligatory if the canal itself is to be utilized to its full extent, *i. e.*, navigable for vessels of 5 feet draught throughout the year.

As will be seen by reference to the report and estimates submitted and published in Report of Chief of Engineers, 1887, pp. 1747 *et seq.*, the only plan which seems to warrant satisfactory results is that of constructing a lock and dam at each of the shoals.

The report suggests that the lock and dam at Colbert Shoals be located at the foot of the shoals, the lock to have an extreme lift of 15 feet, with a dam about 24 feet high.

The other lock and dam to be built below Bee Tree Shoals, the lift of lock to be 12 feet, and height of dam 21 feet.

No official action has yet been taken upon the method of improvement recommended; the projected work, it is estimated, will cost not less than $923,000. An accurate revised estimate will be made when the exact sites and design of the structure are determined.

In this connection attention is respectfully invited to the report above named for the general considerations, previous work, character of the obstructions, etc., pertaining to this very important improvement, so necessary to the present and prospective commerce of the Tennessee River.

In view of the importance of completing and utilizing this improvement at the earliest practicable moment, it would be desirable to have

appropriated the whole amount needed in one sum, thus permitting the work at the two locks to be prosecuted simultaneously.

A favorable consideration of this plan would modify the estimates for the existing project, increasing the same by the amount above stated ($923,000).

The last appropriation, August 5, 1886, for the Tennessee River, limited its expenditure to the Muscle Shoals improvement, but the pending river and harbor bill contains an item for the lower river generally, and if it becomes a law in the form as passed by the Senate, permits of an expenditure in part at the Colbert Shoals, or at the serious obstructions between Chattanooga and Decatur, Ala., to be based upon an approved project for such work as may hereafter be determined upon.

The commerce of the Tennessee River below Chattanooga and above the Muscle Shoals is shown, in part, by the accompanying table of commercial statistics as correctly and definitely as it can be ascertained.

It has been impracticable to obtain data of the commerce below the Muscle Shoals, except in general terms, by reason of changes in the management of the river trade, but it is asserted by those operating the "Tennessee River United States Mail Line" that the lumber shipments have increased about 20 per cent. over those of last year, and that shipments of pea-nuts have fallen short about 25 per cent. and general merchandise 10 per cent. during the same period.

(See Commercial Statistics below Muscle Shoals, Report Chief of Engineers, 1887, p. 1746.)

The following extract from the Report of last year applies in an increased degree to the conditions at this time, and is therefore submitted:

So far as ascertained, the work thus far executed has had no appreciable effect upon insurance or freight rates, the latter being controlled by the competing steam-boats plying upon the river; though some instances are of record where greatly reduced rates have been obtained from the railroad to terminal points because of the improved condition of the channel at the upper entrance to the Elk River Shoals Canal.

The prospective advantages to navigation, as well as present benefits to the community, by continuing the improvement to completion, not alone of the Muscle Shoals and the Colbert Shoals, but of the entire stream below Chattanooga, is held to be by the inhabitants of the Tennessee Valley well-nigh incalculable.

The whole region is rapidly developing as one of the richest in coal and in iron and other mineral deposits, and all that seems necessary to the further development of these unquestioned resources is cheap transportation and an open river to the commercial centers of the Mississippi Valley.

The delays incident to obtaining the needed funds has resulted again in the loss of a working season, which, combined with the disorganizing and scattering of the entire working force, renders it difficult and slow to resume active operations on account of the remoteness of the works from the main routes of travel.

The funds available, if the pending river and harbor bill becomes a law, and the amount herein asked for can be profitably expended in completing the work at the Big Muscle Shoals and the Elk River Shoals, opening the canal to navigation; and in improving the Colbert Shoals, the obstructions through the gorge of the mountains, the sand-bars at Bridgeport and Gilbertsville, etc., and in removing surface obstructions in the lower river.

The obstructions immediately below Chattanooga, including those in the gorge of the mountains, though improved in past years to a considerable extent, are still troublesome.

Their condition and the work needed upon them may be summarized as follows:

(1) *Ross's Towhead*, 1½ miles *below Chattanooga*: Some dredging re-

quired on the bar; a sunken barge and several snags to be removed. The dam is in a fair condition.

(2) *At Moccasin Point*, opposite Lookout Mountain: The channel is shallow and should be deepened by channel work; possibly dredging will be sufficient.

(3) *Brown's Bar*, near foot of Brown's Island, 8 miles below Chattanooga: The present channel is through a rocky reef, is too narrow, and should be widened by blasting away more of the reef.

(4) *Tumbling Shoals*, 9 miles below Chattanooga: This shoal is troublesome at certain stages of the river; reefs of heavy bowlders jut out from the opposite banks and render the channel so crooked that steamers with tows find great difficulty in avoiding the shoals; the channel should be made less crooked by removing the ends of the projecting reefs.

(5) *The Suck*, 2 miles below Tumbling Shoals: The channel here is narrow and the current swift, especially at low water. A good deal was done here in former years, resulting in great benefit.

The plan, which consisted in widening the channel, should be further extended by dredging and the removal of bowlders.

(6) *Richie's Point*, 3 miles below the Suck, has now the least width in this part of the river. Its current is very swift and troublesome. More width should be given by the removal of projecting bowlders.

(7) *Boiling Pot*, 1 mile further down, is most troublesome at high stages; relief can only be had by widening the channel.

(8) *Skillet*, 1 mile below Pot Channel, is specially bad at low water, a reef from left bank contracting the channel and causing a rapid current. Vessels can only ascend at low stages by the aid of lines.

The low-water channel should be widened by removing part of reef.

(9) *The Pan*, 2 miles below Skillet, the last of the mountain obstructions, is especially difficult at high water, a projecting point on the right and a reef immediately opposite causing serious contraction on the higher stages. Some rock excavation is needed.

A few minor shoals between the mountains and Bridgeport also require attention, and it is very essential that an instrumental survey of the river below Chattanooga be made as soon as practicable, in order to obtain detailed maps of all the obstructions, together with a complete profile of the river, so that estimates can be revised and projects for the radical improvement submitted, based upon the necessary and definite data that can only be thus obtained.

Original estimates of cost of improving the Tennessee River below Chattanooga	$4,133,000.00
Modified and increased in 1888	923,000.00
Total estimates	5,056,000.00
Amount appropriated	2,958,000.00
Amount expended	2,957,377.28

Money statement.

July 1, 1887, amount available		$94,883.13
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$90,880.76	
July 1, 1888, outstanding liabilities	3,379.65	
		94,260.41
July 1, 1888, balance available		622.72
Amount appropriated by act of August 11, 1888		250,000.00
Amount available for fiscal year ending June 30, 1889		250,622.72

Amount (estimated) required for completion of existing project.....$1,848,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890..... 1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga from July 1, 1887, to June 30, 1888.

Articles.	Quantities	Articles.	Quantities.
Brick.....number..	500,000	Logs.....feet B. M..	24,500,000
Coal.....tons .	32,000	Lumber.....do....	1,024,000
Flour.....barrels..	4,280	Merchandise.....pounds..	7,228,000
Grain.....bushels..	1,447,955	Passengers.....number.	52,370
Hay.....tons..	1,400	Sand.....cubic yards..	6,445
Iron ore.....do ...	84,000	Shingles.....	120,000,000
Live-stock.....head..	81,220	Wood.....cords..	623

Tennessee River below Chattanooga and above Muscle Shoals from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Brick.....number..	23,000	Live-stock.....head..	76,634
Coal.....tons..	7,000	Lumber.....feet B. M..	503,150
Cotton.....bales..	5,720	Merchandise.....pounds..	14,999,620
Flour.....barrels..	4,276	Passengers.....number..	65,399
Grain.....bushels..	235.411	Sand.....cubic yards..	2,300
Hay.....tons..	321		

List of steam-boats plying on Tennessee River.

ABOVE CHATTANOOGA.

Names of boats.	Character.	Length.	Breadth.	Depth.	Tonnage.
A. G. Henry.....	Stern-wheel ..	145	30.00	3.02	249.45
M. H. Clift.....	....do	105	19.00	2.00	68.63
Rockwood.....	....do	130	25.00	4.00	226.26
May Tillman.....	....do	79	15.00	3.00	32.72
Water Lilly.....	....do	112	21.00	3.00	141.17
J. C. Warner.....	....do	142	31.06	4.06	347.43
W. L. Dugger.....	....do	130	27.00	3.08	224.13
Citico.....	....do	75	13.00	3.00	31.30
Dayton.....	....do	142	24.07	3.08	357.49
P. Dickinson.....	....do	122	28.00	4.00	205.97
Myra.....	....do	100	18.00	3.05	148.42
J. R. Hughes.....	....do	98	17.00	3.00	186.15
Pin Hook.....	....do	94	18.00	3.00	160.36
W. L. Norton.....	....do	68	12.00	3.00	63.01
Tallassee.....	....do	60	12.00	2.00	44.32

BELOW CHATTANOOGA AND ABOVE MUSCLE SHOALS.

J. H. Johnson.....	Stern-wheel...	141.02	23.09	4.02	169.90
R. C. Gunter.....	... do	153.00	28.00	4.00	565.34
Dixie.....	....do	80.00	19.00	3.00	110.78
M. V. Reed.....	....do	65.00	24.00	3.00	111.25
Herbert.....	....do	134.00	27.00	3.00	167.00
Wyeth City.....	....do	120.00	22.05	4.00	255.96

BELOW MUSCLE SHOALS.

John Gilbert.....	Stern-wheel ..	250	47	6.00	700
W. T. Nisbet.....	do	230	44	6.06	625
Clyde.....	....do	206	40	5.06	450
City of Florence.....	....do	183	37	5.03	425
W. H. Cherry.....	....do	.....	.....	.....	.....
C. Smith.....	....do	.....	.....	.....	.....

A A 2.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

This stream rises on the western slope of the Blue Ridge, in North Carolina, and enters Tennessee at Paint Rock, about 121 miles from the mouth of the river.

The French Broad unites with the Holston about 4½ miles above Knoxville, thus forming the Tennessee River. This conclusion is now generally accepted, Knoxville being constructively placed on the Tennessee by the legislation making appropriations for the Tennessee River.

In the report on the improvement of the Tennessee River above Chattanooga more extended comments are made in reference to this matter.

The State of Tennessee, in 1836, appointed commissioners to superintend the improvement of Seven Island Shoals, about 30 miles below Dandridge, which makes it evident that the French Broad River received a part of the appropriations of the State for improving the rivers forming the then so-called "East Tennessee District."

Some work by the State was also carried on above Dandridge, for several of the old State dams in this section of the river were utilized by repairing them in 1881; but these old dams generally have been removed in the progress of work under the present project.

An examination was made in 1870 and report rendered in 1871. A re-examination in Tennessee was ordered by Congress in 1875, "from the Holston to Leadvale."

The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale—mouth of the Nolichucky River—a distance of 90 miles, the river was impeded by the surface obstructions usually found in mountain streams, and having a fall of about 1 foot per mile. This section is, however, exceptionally beautiful, being broad and well adapted to navigation.

From the mouth of Nolichucky River to the line dividing the States of Tennessee and North Carolina, a distance of about 31 miles, the river is not susceptible of improvement, except by slackwater navigation at a cost wholly disproportionate to the benefits likely to accrue to its present or prospective commerce.

The present plan therefore limits the work to obtaining a good navigable channel sufficient to pass steam-boats not drawing more than 2½ feet during the season of low water from Leadvale to the mouth of the river. This to be effected by removing bowlders, snags, overhanging trees, etc., reducing bars and reefs, and building the riprap dams necessary to contract the water-way.

Work in channel and on dams was in progress at the close of the last fiscal year, and was continued until October, 1887, on the shoals at Evans' Island, Fains' Island, Seven Islands, and other points.

Location.	Excavation, cubic yards.				Quarrying, cubic yards.		Dams, cubic yards.		Snag-boats.		
	Solid rock.	Loose rock.	Sand and gravel.	Earth.	Riprap.	Stripping.	Spur riprap.	Length.	No. of snags removed.	No. of snags cut up.	No. of trees cut down.
Fain Island Shoals	7	105	300	325	1,404	587	788	135	4	.....	91
Evans' Island Shoals	.....	.....	.....	.....	168	420	.....	306	28	.....	26
Seven Island Shoals	.....	.....	300	325	154	326	284	36	5	6	10
Total	7	105	600	650	1,726	1,333	1,072	477	37	6	127

As a matter of economy in outlay for boats, superintendence, etc., active operations were carried on in connection with the work to be done on the Upper Tennessee; therefore, on the exhaustion of available funds for this improvement, the working force, boats, etc., in charge of Superintendent R. R. Thacher, were dropped down to Baker's Shoals of the Tennessee River, near Knoxville.

The commerce of the French Broad River is considerable and rapidly increasing, and consists of logs, lumber-rafts, grain, shingles, marble, sand, and general merchandise.

The prospective advantages to navigation, as well as present benefits to the people living near this stream, by the completion of the projected work, are the increase of transportation facilities for the products of the rich agricultural and mining regions of its upper waters, by the obtaining of a safe navigable channel, about 30 inches deep at low water, below the mouth of Nolichucky River, about 1 mile above Leadvale.

The improvements already made, though limited and incomplete, appear to give satisfaction to the raftsmen and boatmen navigating its waters.

The mineral wealth of the mountain region drained by this river and its tributaries awaits the completion of a safe and economic highway from mine to market to aid in its development.

Should the river and harbor bill now pending in Congress become a law, any appropriation therein for this work, and the amount herein asked for, can be profitably expended under the present project for improving the channel below Leadvale, principally by channel excavation and the building of wing-dams necessary to contract the water-way. Active operations to be renewed at the worst shoals obstructing the lower stretch of river, reaching from Mill Shoals to Bryant's Shoals, a distance of about 50 miles.

The estimate of cost of improving French Broad River, from Leadvale to mouth	$150,000
Amount appropriated	28,000
Amount expended	28,000

Money statement.

July 1, 1887, amount available		$4,727.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,682.96	
July 1, 1888, outstanding liabilities	44.44	
		4,727.40
Amount appropriated by act of August 11, 1888		10,000.00
Amount (estimated) required for completion of existing project		112,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels	108,380	Wood ..... cords	129
Hay ..... tons	122	Marble ..... cubic yards	4,200
Live stock ..... head	370	Sand ..... do	29,650
Logs ..... feet B. M.	6,940,000	Stone ..... do	5,400
Lumber ..... do	1,457,000	Merchandise ..... pounds	9,140,000

A A 3.

IMPROVEMENT OF LITTLE TENNESSEE RIVER, TENNESSEE.

This river, the "Tannassee" of the aborigines, and "Tennessee" of the early settlers, rises in the Blue Ridge, flows northwest for about 134 miles, and enters the Holston or Big Tennessee near Lenoir's, about 47 miles below Knoxville and 142 miles above Chattanooga.

Two examinations of this stream as the "Tennessee River" were authorized by act of 1874 from above "the mouth of Holston River to the Chilhowee Mountains, Tennessee," and by act of 1875 "from the Chilhowee Mountains to the Georgia line." These examinations were made in October, 1874, and August, 1875, respectively:

The act of 1881 provided for a third examination, which was made in November of that year, below "the mouth of the Tellico River," a distance of about 13 miles, and upon this examination the present project and estimates are based.

The obstructions were found to be rock-reefs, gravel bars, bowlders, snags, etc., and the plan of improvement adopted was to remove the surface obstructions, reduce the reefs and bars, and build wings-dams where necessary, to contract the water-way, so as to secure a navigable low-water channel 40 feet wide and 2 feet deep below the mouth of Tellico River.

Only one appropriation, that of August 2, 1882, $5,000, has been made for this work, and it was expended to advantage; for the Report of the Chief of Engineers for 1884 shows that "the work done is very highly spoken of by river-men and others interested in the improvement, and it will doubtless satisfy all the demands of commerce when completed according to the present plan."

No work has been done since December, 1883, and from its character as a mountain stream the improved channel would be found on examination to be much obstructed by accumulated snags and drift brought down by floods of the last five years.

The commerce consists principally of logs, lumber, grain, and general merchandise.

The "commercial statistics," herewith submitted were collected under the direction of the engineer officer in charge, but they by no means represent the entire commerce of this stream, because its trade seeks a market in rafts and on flat-boats, consequently making it very difficult to obtain complete and reliable data.

The appropriation herein asked for ($10,000) can be profitably expended in removing the surface obstructions from the improved channel, and in continuing the improvement by building wing-dams, etc., as projected.

In support of this estimate I quote from my report of last year (1886–'87):

> The prospective advantages as well as present benefits to navigation by continuing the proposed improvement to completion, are the securing of a safe, navigable channel for rafts and flat-boats, and for the light-draught steam-boats plying the upper Tennessee, the lengthening of the season of navigation, and the diminishing of danger of passage during the "tides" caused by heavy rains, and as the river forms the principal highway for the products of the rich agricultural and mineral country through which it passes, these interests would be greatly developed and extended by the opening up of an improved channel for a safe and economical line of transit to the business centers on the Tennessee.

Estimate for improving Little Tennessee River below mouth of Tellico River	$23,724
Amount appropriated	5,000
Amount expended	5,000

Money statement.

Amount (estimated) required for completion of existing project	$18,724.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Grain ... bushels	95,650	Logs ... feet, B. M.	2,740,000
Merchandise ... pounds	985,000	Lumber ... do	220,000

A A 4.

IMPROVEMENT OF HIAWASSEE RIVER, TENNESSEE.

This stream rises in Georgia on the western slopes of the Blue Ridge. Its course of about 135 miles is nearly at right-angles to the Tennessee, which it enters 72 miles below the mouth of Clinch River, and 38 miles above Chattanooga.

In 1830, the State of Tennessee included this river, in the East Tennessee District, as worthy of improvement, and some work was done by the State, but with little permanent benefit to commerce.

An examination and estimate of cost were made in October, 1874, upon which the present plan of improvement is based. The estimate was, however, increased in 1885.

Light-draught steam-boats ascend to Charleston, Tenn., about 20 miles, but the head of navigation for rafts and flat-boats is at Savannah Ford, 33 miles from mouth of the river.

The bridge of the East Tennessee, Virginia and Georgia Railroad crosses at Charleston. This structure has no draw and is so low that when the river is at a good boating stage even the smallest steam-boats are unable to pass through its spans.

The channel obstructions are such as are usually found in mountain streams—rock-reefs, gravel-bars, snags, and overhanging trees.

The present plan is to reduce the reefs and bars, remove bowlders, snags, etc., from the channel and build the wing-dams necessary to obtain a channel 40 feet wide, and 2 feet deep at average low water as far as Savannah Ford.

No work has been done during the fiscal year, there being no available funds.

The commerce of this river is increasing, and consists of logs, grain, and general merchandise, the grain coming to market on flat and keel boats from the upper waters principally, and the merchandise on small steamers plying below Charleston to points on the Tennessee River.

The prospective advantange to navigation, as well as immediate benefits to the community by continuing the work to completion, are the opening and maintaining of a good navigable channel at ordinary stages of water for light-draught steam-boats, etc., to Charleston, and for flat-boats, etc., to Savannah Ford.

The original estimate of cost of improving Hiawassee River, Tennessee, was	$20,000
Increased in 1885 to	36,500
Amount appropriated	34,000
Amount expended	34,000

Money statement.

Amount appropriated by act of August 11, 1888	$1,000.00
Amount (estimated) required for completion of existing project	1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels	181,702	Logs ..... feet, B. M.	1,500,000
Live stock ..... head	760	Merchandise ..... pounds	870,000
Hay ..... tons	320		

A A 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River, known as the Pellissippi by the first explorers, rises in the Cumberland Mountains in southwestern Virginia, and discharges its waters into the Tennessee near Kingston, Tenn., having a course of about 165 miles in Virginia and 230 miles in Tennessee, and draining an area of about 1,436 square miles.

In 1830, 1842, and subsequent years, the State of Tennessee made appropriations for improving the channels of her navigable rivers, and in 1844 appointed commissioners to direct the work to be done on the Clinch River, which consisted of removing snags, gravel-bars, loose rock, and building wing-dams. No permanent benefit resulted from the imperfect work done by the State under the loose contract system adopted, and several of the dams have been removed as obstructions, and others repaired or modified, under the present project.

Within the limits of Virginia some money has also been expended in improving this river by a chartered company, though that State has made no appropriation for that purpose so far as known.

The appropriations made by Congress for improving this river provide only for work to be done in the lower section of 230 miles, that is in Tennessee.

An examination of this stream was made in 1875, upon which the existing project is based, consisting in the removal of ledges, rock-points, gravel bars, bowlders, snags, and overhanging trees, and building rip-rap dams, so as to obtain at ordinary low water a channel-depth of 2 feet from the mouth to Clinton, about 70 miles, and 1½ feet from Clinton to Walker's Ferry (Haynes), about 75 miles. From Walker's Ferry to the Tennessee State line, 85 miles, the only work that can be done to advantage is to reduce the rock-ledges and remove bowlders, etc., sufficient to assist flat-boat navigation during the so-called "rain-tides."

With the funds appropriated by act of August 5, 1886, active operations were resumed in July at Cloud's Shoals, about 113 miles from mouth of river, by blasting a channel through the ledges, and using the rock in building wing-dams.

Cloud's Shoals are about 1½ miles long, the upper part being very *shallow*, and rafts or flat-boats were liable to be "hung up" there on a *falling river*; but absolute loss seldom occurs.

Seven dams have been built at this obstruction—five on the left bank and two on the right bank—aggregating a length of 1,704 linear feet.

Dam No. 1, begun in 1881, was extended 42 feet, making its entire length 300 feet. Total length of dams built during the fiscal year at Cloud's Shoals, 1,446 linear feet.

At Hitche's Shoals the old dam behind the island was removed and a new dam built at the head of the island.

When the work was finished at Cloud's Shoals the working force moved down-stream 18 miles to Hibb's Shoals, removing en route fish-trap dams, loose rock, and other surface obstructions, and blasting rocky points from ledges. At the foot of Nelson's Eddy an old trap-dam was partly taken out by removing the rock from the left to the right wing of the dam, contracting the water-way, and thus assisting low-water navigation.

Another old trap-dam on the sand-bar, about amile below, was removed, and the rock used to build a wing-dam just below the bar.

Near Powell's River two trap-dams obstructing the channel were modified by removing rock from one wing and placing it on the other wing of the dams.

At the mouth of Powell's River a new trap-dam was found. The logs were cut out and the rock placed on right wing of dam, thus assisting to clear the channel of gravel, etc.

At Hibb's Shoals the obstruction is formed by three bars of solid rock, crossing the river nearly at right angles to the current, and about 150 feet apart. Here the river is about 400 feet wide; therefore a rise is less advantageous than at other points where the river is not so spread out.

On account of the reefs a "hang up" is a more serious matter than at Cloud's Shoals, for the rafts usually go to pieces and the boats sink.

A channel 150 feet wide was blasted through the reefs, and a heavy dam at right angles to the current was built up to a height of 4 feet, with the object of setting back the water on the reefs above. This work is left incomplete, the available funds being exhausted.

Location.	Excavation, cubic yards.			Quarrying, cubic yards.		Dams.		Snag-boats.			
	Solid rock.	Loose rock.	Sand and gravel.	Rip-rap.	Stripping.	Length in cubic yards.	Crib, feet.	No. of snags removed.	No. of snags cut up.	No. of trees topped.	Cords of drift removed.
Cloud's Shoals	371	78	95	421	12	1,072	30	.....	.....	.....	.....
Hibb's Shoals	.....	.....	.....	286	38	237	.....	3	5	6	26
Total	371	78	95	715	50	1,309	30	3	5	6	26

From Cloud's Shoals to Hibb's Shoals (distance 18 miles):

Trap-dams removed	cubic yards	66
Fish-traps removed	number	8

The Clinch River is used principally for the passage of rafts and for flat-boat navigation on the sudden rises or "rain tides" common to the mountain streams of this section, though small steam-boats ascend as high as Clinton, 70 miles.

At Clinton the river is spanned by the bridge of the East Tennessee, Virginia and Georgia Railroad Company (Ohio and Jellico Division). This bridge is of four unbroken spans, two of 150 feet and two of 120 feet each, the bottom chord being about 51 feet above low water. Boatmen complain that the piers are an obstruction to navigation.

Exclusive of the natural barriers of rocky ledges and gravel-bars, the most troublesome, vexatious, and dangerous obstructions are the fish-trap dams, which are veritable "traps," not only to fish, but also to the boat or raft that unfortunately strikes them, resulting usually in the boat being sunk or the raft broken up.

These "traps" and fish-trap dams are put in the channel during the low-water season, and are always located where the fall is greatest and the water shallowest; and as they are put in when boats and rafts are not running, and extend entirely across the river, skill and foresight can not always guard against loss, for it is unknown to the river-men how much of a rise is necessary to pass their rafts or boats over in safety.

These traps, and the dams also when necessary, have been removed by the working force as surface obstructions in the navigable channel; some of them two or three times.

The river-men, as a class, are not able, financially, to bear these losses; hence these complaints. The owners or builders of the traps (fishermen), as a class, are equally as poor; and if judgments of compensatory damages were obtained, they would have little real value to the losers of boats, etc.

Apparently the laws of Tennessee authorize the construction of these dams in the navigable waters of that State, *e. g.:*

Acts of Tennessee, forty-fourth general assembly, 1885, chapter 49, is an "act to amend the fish law:"

SECTION 1. *Be it enacted by the general assembly of the State of Tennessee,* That any person who is a citizen of this State may catch fish by means of any trap, box, basket, bait-net, any of whose meshes or openings are not less than one and one-half inches in diameter, in any stream of this State as far as navigable.

SEC. 2. *Be it further enacted,* That all laws and parts of laws in comfliict with the provisions of this act be, and are hereby, repealed.

SEC. 3. *Be it further enacted,* That this act take effect from and after its passage, the public welfare requiring it.

Passed March 20, 1885.

J. A. MANSON,
Speaker of the House of Representatives.
C. R. BERRY,
Speaker of the Senate.

Approved April 2, 1885.

WILLIAM B. BATE,
Governor.

This appears to be an express legislative grant to fish by the means specified in the Clinch River, in Tennessee, "as far as navigable." It is conceded that a piscary may be granted by the State of Tennessee, provided the free use of the waters for purposes of navigation and commercial intercourse be not interrupted.

It would appear to be a useless expenditure of public funds in the improvement of Clinch River to remove the fish-trap dams during one year only to find them rebuilt and forming serious obstructions for the next season's operations. Legislation or executive action is certainly demanded sufficient to prevent any one closing or obstructing the navigable channel.

The Clinch River is the great highway and outlet for the timber, zinc ore, and other products of the rich agricultural and mining sections drained by this stream and its affluents, exceeding an area of 4,500 square miles, there being no railroad readily accessible to the varied interests of its upper waters.

The people of the Clinch Valley have promptly utilized the improvements already made, and the commerce of the river is reported as rapidly developing.

Freights are floated to a market at Clinton, Kingston, Chattanooga, and other points, usually on the "rain tides" or sudden rises, in flat-boats manned by the men owning the boats and cargo, who sell anywhere along the route; consequently it is very difficult to get complete "commercial statistics," but the data hereinafter reported are only a small part of the entire commerce of this stream.

In this connection attention is called to the fact that the report of the commerce of the "Tennessee River above Chattanooga" is largely made up necessarily of the aggregated shipments from its upper tributaries.

The lumber business of Chattanooga, one of the largest industries of that city, receives the greater part of its log supply by way of the Clinch River.

It is this tributary commerce of the minor water-ways that increases so heavily the commerce of the main streams.

The prospective advantage to navigation by continuing the improvement to completion are the lengthening of the season of navigation for the passage of rafts and boats and providing a safe channel at ordinary low water of 2 feet from its mouth to Clinton, and of 1½ feet from Clinton to Walker's Ferry (Haynes).

Should the river and harbor bill now pending in Congress become a law, any appropriation therein for this work, and the amount herein asked for, can be profitably expended in completing the work at Hibb's Shoals, and in continuing the improvement at Brushy Bend Shoals, Bletcher's Shoals, and other serious obstructions, and in clearing, widening, and deepening the channel below Walker's Ford, as provided under the existing project.

The original estimate for improving Clinch River, in Tennessee, was	$26,400.00
Increased in 1885 to	50,000.00
Amount appropriated	26,000.00
Amount expended	25,958.09

Money statement.

July 1, 1887, amount available		$4,425.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,313.15	
July 1, 1888, outstanding liabilities	70.84	
		4,383.99
July 1, 1888, balance available		41.91
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,041.91
Amount (estimated) required for completion of existing project		19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		19,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Grain ... bushels	105,000	Logs ... feet B. M.	20,300,000
Cedar posts ... number	30,000	Merchandise ... pounds	125,000
Lumber ... feet B. M.	270,000		

A A 6.

IMPROVEMENT OF DUCK RIVER, TENNESSEE.

The Duck River rises in the plateau of the barrens, near the center of the State of Tennessee, and, after a course of about 250 miles, enters the Tennessee River 14½ miles above Johnsonville.

In 1846 the State of Tennessee sought to improve this stream by locks and dams, granting certain franchises to the Duck River Slackwater Navigation Company for that purpose. By this company a lock and dam were built near Columbia, Tenn., about 55 miles above Centerville, but the enterprise was abandoned without effecting any permanent benefit, by reason of suits for damages and other causes. The company was perpetually enjoined in 1853 from the prosecution of the work proposed, and the charter, it is thought, expired by limitation in 1871.

An examination from the mouth of this river to Centerville, Tenn., a distance of 68 miles, was made in September, 1879, under the provisions of the river and harbor act of that year.

The obstructions were found to be gravel-bars, bowlders, caving banks, overhanging trees, and numerous snags, logs, and trees in channel.

The plan adopted was to remove the surface obstructions, reduce the bars, and build wing-dams, so as to secure about 3 feet of water during the season of navigation, from four to six months of each year.

Appropriations, aggregating $13,000, were made for this work by acts of June 14, 1880, March 3, 1881, and August 2, 1882, and active operations were begun in September, 1880, and continued at intervals until December, 1882, when the available funds were exhausted.

The Annual Report of the Chief of Engineers for 1883 states that "the [Duck] river is now in a fair navigable condition from Centerville to its mouth," * * * and "that the improvement accomplished will answer all the present needs of commerce for "several years at least," * * * and a like report has been rendered each succeeding year.

No examination of this stream has been made since the work was stopped, and though the channel has been much improved, yet "the work contemplated by the existing project has not all been done;" and from the character of the stream it may safely be stated that the channel needs the clearance of the accumulated snags, logs, etc., of the past six years; and that a small annual outlay is necessary to maintain the benefits secured to commerce by the work already done. Snags, drift, trees falling into channel from caving banks, etc., should be removed each year after the annual floods. An examination of the improved channel is desirable.

The commerce of Duck River consists principally of corn, peanuts, logs, and general merchandise, but it was not practicable to obtain sufficient data to give tabular statistics.

It is reported that about 60,000 bushels of corn and 15,000 bushels of peanuts are shipped annually.

A steam-boat, the *Lucy Robertson*—length, 90 feet; width, 20 feet; tonnage, 82 tons—plies regularly upon this river.

The opening to commerce of hundreds of miles of the navigable waters of the Tennessee River, by the near completion of the Muscle Shoals Canal, will necessarily increase the commerce of the large affluents of that river and develop the vast resources of the valleys of those tributary streams.

Immense deposits of iron ore, and heavily timbered lands are found along the Duck River, and the agricultural products raised in its valley are by no means small; therefore the amount herein asked for ($10.000) can be profitably expended in clearing the channel of surface obstructions, thus keeping effective the work already done as indicated, and in carrying to completion the plan of operations as originally projected, if Congress deems it advisable to complete the improvement.

Estimate for improving Duck River, Tennessee	$35,718
Total amount appropriated	13,000
Total amount expended	13,000

Money statement.

Amount (estimated) required for completion of existing project	$22,118.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A A 7.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River rises in Kentucky, on the western slope of the Cumberland Mountains, and after a winding course of about 700 miles, enters the Ohio at Smithland, Ky.

The improvement of this river was undertaken by the States of Kentucky and Tennessee as early as 1830, but with only temporary beneficial results. Kentucky made appropriations for surveys and improvements of the river within its borders, and Tennessee passed an act establishing a board of internal improvement, appropriating $60,000 for the river lying west of the Cumberland Mountains and east of Tennessee River.

In 1870, Congress authorized a survey of the Cumberland, from the head of navigation to the mouth of the river, and upon that survey, or rather examination, is based the present project for the improvement below Nashville, the estimates therefor being increased in 1884; and upon this examination is also based the project for the work done since 1876, between Nashville and the foot of Smith's Shoals, until the adoption of the existing project for improving the river above Nashville by locks and dams.

The work done on the Smith's Shoals, extending 10 miles above the head of navigation for steam-boats (Burnside, Ky.), was based on a survey made in 1875, the estimates being increased in 1879.

A reconnaissance of the Upper Cumberland above the falls was made in 1880.

From 1832 to 1838, Congress made five appropriations, aggregating the sum of $155,000, of which $20,000 has been applied below Nashville, and $135,000 for the general river.

From 1838 to 1870, no appropriations were made by the National Government for this work.

From 1871 to 1876, inclusive, twelve appropriations were made, aggregating the sum of $676,000, which has been applied to improving the river channel, above and below Nashville, upon the several sections as specified and provided for by the several acts making the appropriations.

The obstructions in this river are of the same general character throughout its course, consisting of rock-ledges, gravel-bars, bowlders, snags, overhanging trees, and rapid currents, and of mill-dams, above the mouth of Jellico, Ky.

The methods of improvement adopted and carried out have been to remove surface obstructions, snags, trees, bowlders, etc., reduce the gravel-bars, blast a channel through rock-reefs, to build riprap dams to contract the water-way where deemed necessary to secure an additional channel depth.

(1) BELOW NASHVILLE (ABOUT 192 MILES).

This section of the Cumberland is navigable from Nashville to the mouth of the river for all steam-boats plying upon it for about six months in each year, and for boats drawing not more than 3 feet, from six to eight months, and for boats of about 16 inches draught the entire year, except at an unusually low-water season, when the mouth of the river, at Smithland, Ky., is seriously obstructed by the formation of sand-bars, the volume of the Cumberland at that stage being insufficient, unaided, to effectually scour and keep open the Kentucky Chute of the Ohio to the deep waters of that river below Cumberland Island.

Work was in progress at the beginning of the fiscal year, and was continued until the close of December, when the available funds being nearly exhausted and inclement weather setting in, active operations were entirely suspended, and the boats with the other engineer property were towed to Mill Creek and moored in care of watchmen.

Operations were carried on by two working parties, with snag-boats, quarter-boats, etc.

The channel was worked from Nashville to the mouth of the river, clearing the channel of snags, loose rock, overhanging trees, etc.

The work of channel excavation and building of wing-dams was continued at Harpeth Shoals, Tennessee, and Line Island Shoals and Gatlin Shoals, Kentucky, etc.

Locality.	Quantity.	Locality.	Quantity.
Harpeth Shoals:		Gatlin Shoals:	
Riprap dam required ..cubic yards..	524	Rip-rap dam built....cubic yards..	1,764
Brush placed in dam .....cords..	4	Riprap stone quarried .....do....	1,479
Willows planted in dam ..number..	104	At various points on lower river:	
Line Island:		Loose stone taken from channel, cubic yards	18
Rip-rap dam built.....cubic yards..	3,512	Snags removed.....number..	517
Rip-rap stone quarried .....do....	3,315	Overhanging trees cut..... do ..	1,065
Brush placed in dam .....cords....	6		

An improved channel at the most dangerous obstructions, and a lengthened season of navigation has been secured below Nashville.

The commerce of the lower river consists principally of grain, tobacco, lumber, coal, iron, general merchandise, and passengers, and forms an important link in the great chain of the Mississippi system, reaching out after, and supplying facilities for, water communication between the great river cities of the West, Northwest, and Southwest and the entire valley of the Cumberland River and its tributaries.

The reduction or falling off of river business during this fiscal year is due to the unusually low water of the fall of 1887 and spring of 1888, combined with the short crops in grain, etc.

Explanatory of the work done and to be done, I repeat the statement in the Annual Report of last year (1887):

From 1882 to the present time the work done below Nashville has been simply to clear the channel of surface obstructions; to improve from time to time some of the worst shoals, and thus to secure safety to the life and property afloat during a lengthened season of navigation; but as Congress has already provided for a radical improvement of the river above Nashville by a system of locks and dams, beginning with a lock at the lower Nashville Island, it may reasonably be anticipated that the section below Nashville will ultimately form a part of a complete system of canalization, to the advantage of navigation and the general interests of the Lower Cumberland, the river forming the highway, and in many cases the only means of transit for persons and property, between the villages and towns scattered along its lower course.

In the pending river and harbor bill, provision is made for a survey of the "Lower Cumberland River from Nashville to mouth, to ascertain if necessary to establish locks and dams," which, if it become a law, will provide for an urgent need, that of a systematic survey of the Lower Cumberland, as stated in the next preceding paragraph.

The difficulty of entering the mouth of the Cumberland River at low water, caused by the forming of shoals in the Kentucky Chute of the Ohio, is a very serious one, and the Chief of Engineers, on April 28, 1888, constituted a Board of Engineers "for the purpose of considering and recommending a plan for the improvement of the navigation at the mouth of the Cumberland River." This Board met, visited the mouth of the Cumberland, and reported, but at this writing the official action of the War Department is awaited upon the recommendations and plans of the Board.

In general terms, the improvement suggested by the Board was the construction of a pile and brush dam with crib superstructure, at an estimated cost of about $130,000, to which must necessarily be added the cost of protecting the bank of the Cumberland Island from erosion.

With the report of the Board was transmitted an explanatory statement by the engineer officer in charge of the work of improving Cumberland River, having in view the making of the report more clear and complete, as a representation of the matter from the stand-point of the navigation and commercial interests of the Lower Cumberland.

This statement suggests that authoritative action be had establishing the exact locale of the mouth of the Cumberland, and also invites attention to the possible necessity of rebuilding the so-called Cumberland Dam, and closing the Dog Island Chute of the Ohio in order to give the needed relief at the mouth of the Cumberland.

No work has been done at the mouth of the river since 1884, and some advantage was obtained temporarily by dredging and construction of brush-dams, but the conditions now are practically what they were when work was begun in 1881, supplemented by the tendency to scour along the Kentucky shore, and thus causing considerable caving of the left bank, and consequent riparian damage.

The funds, $10,000, as the item now stands for improving Cumberland River below Nashville, that will be available, should the pending river and harbor bill become a law, are altogether inadequate wherewith to begin any radical improvement of the mouth of the river, if the needs of the entire Lower Cumberland receive any proper consideration in the division of the appropriation.

Any funds that may be available, and the amount herein asked for, can be profitably expended during the fiscal year ending June 30, 1890, in continuing the work of removing snags and other surface obstructions from the channel of the lower river, and continuing the improvements at Gatlin Shoals, and the most serious obstructions below

Gatlin Island; also, to commence the radical improvement of the mouth of the river under such plan as may be hereafter adopted; and basing the expense of the proposed work upon the estimate of the Board of Engineers, already submitted, the estimates of cost for a radical improvement under the existing project are necessarily modified and increased by the sum of $150,000.

The original estimate of cost of improving the Cumberland River below Nashville, as modified in 1884	$348,000.00
Increased in 1888 by	150,000.00
Total estimates	498,000.00
Amount appropriated	255,000.00
Amount expended	254,858.35

Money statement.

July 1, 1887, amount available		$11,350.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,005.58	
July 1, 1888, outstanding liabilities	203.43	
		11,209.01
July 1, 1888, balance available		141.65
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,141.65

Amount (estimated) required for completion of existing project	233,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(II.) ABOVE NASHVILLE 337 MILES—FROM NASHVILLE TO HEAD OF SMITH'S SHOALS.

The Cumberland River is navigable to Point Burnside, Kentucky, 327 miles, for steam-boats drawing not more than 3 feet, from four to six months of each year, and for boats of greater draught from two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 118 miles), the river is navigable for steam-boats of 2½ feet draught, from six to eight months, and for those of greater draught four or five months. Steam-boats of light draught can ascend to Burkeville, 238 miles above Nashville, for from five to seven months, and larger boats four or five months.

A survey was made in 1883, and estimates and report submitted in 1884, providing for a complete system of locks and dams from Nashville to head of Smith's Shoals.

The act of July 5, 1884, appropriated $50,000 for an improvement to be made in accordance with the provisions of Ex. Doc. 129, Senate, Forty-eighth Congress, first session, which provides that the locks "should be about 60 feet wide and 250 feet between miter-sills, though perhaps smaller dimensions would answer the purpose."

By act of August 5, 1886, Congress appropriated $75,000 for this work of canalization, specifically providing for "commencing with the lock at or near the lower island at Nashville."

Map of the sites of the proposed lock and dam abutment, together with plans for the construction of the lock and dam, have been submitted to the Chief of Engineers and approved, the lock dimensions be-

ing 280 feet long, 52 feet wide, having walls 26 feet high, with 4 feet of water on lower and 5 feet on upper miter-sill.

Surveys were made and observations recorded of the current velocities at site of Lock No. 1, to ascertain the proper height of lock-walls above the permanent dam, and soundings made and mapped for 3,500 feet below Page's Branch.

A survey was also made and water-gauges established from Hermitage Reef to the lock-site, a distance of about 18 miles, thus satisfactorily determining the height to which the dam of Lock No. 1 should be carried—13 feet above low-water mark—and thus, also, showing that the site of Lock No. 2 of the system will be in the vicinity of Beck's Ripple, about 14 miles above Lock No. 1.

On the upper miter-sill of the lock 5 feet of water is secured while the dam is perfect, but the crest of any dam is subject to many contingencies, so that provision is made whereby if its height be reduced 1 foot by abrasion or other cause, the required 4 feet of channel depth will still be maintained.

Congress having provided by act approved April 24, 1888, for the purchase or condemnation of the land necessary for the site of lock, abutment, and keeper's dwelling, as soon as title, approved by the Attorney-General of the United States, can be obtained to the lands required work will be begun constructing coffer-dam, excavating lock-pit, building keeper's dwelling (to be used as an office and store-house during the progress of the work), quarrying and cutting stone, and laying masonry of the lock; this work will be done by contract, provided reasonable bids are made therefor.

As stated in my last annual report (1887), "an act to give consent to the purchase by the United States of such lands as may be required for sites for lock and dam, etc., at or near the lower island at Nashville, and to grant cession of the jurisdiction over said lands," was approved by the governor of the State of Tennessee March 22, 1887.

An examination of the lock-site shows that the excavation for the lock-pit will be in solid rock, estimated at 10,700 cubic yards. This excavation is necessarily costly, but the excavated stone will be stored and finally placed in the permanent dam. It may also be found possible to utilize a portion of the rock in situ as a part of the bank-wall of the lock, thus materially reducing the item of expenditure for dam and lock masonry.

Active operations were carried on during the months of August, September, October, and November, clearing the channel from Burksville to Nashville of snags and other surface obstructions, excavating rock and gravel, extending and repairing riprap dams, etc.

Location.	Excavation, cubic yards.			Quarying, riprap stone, cubic yards.	Dams, spur riprap, cubic yards.	Snag-boats.		
	Solid rock.	Loose rock.	Sand and gravel.			No. of snags removed.	No. of snags cut up.	No. of trees cut down.
Bartlett's Bar	.....	.....	.....	115	115	.....	.....	.....
Sand Shoals	.....	.....	.....	100	552	.....	.....	.....
From Burksville, Ky., to Nashville	19	122	10	.....	4	602	316	926
Total	19	122	10	215	721	602	316	926

The commerce of the Upper Cumberland is shown, in part, by the accompanying statistics.

The prospective advantage to the commerce, as well as present benefits to the community, are the extension of the lower river trade to points above Nashville, as fast as the locks can be completed and utilized and for the upper river the opening up of a cheap and safe means of transportation for the almost unlimited mineral and forest resources of the Upper Cumberland Valley.

A steam-boat line is operating between Burksville and the head of navigation—Burnside, independent of the Nashville trade.

It is deemed advisable to repeat the recommendation of the last annual report—

That the section of river from Burnside to the Kentucky State line has claims for immediate improvement quite as great as those on the portion directly above Nashville.

The facilities for carrying on the improvement from Point Burnside are equal if not superior to those at Nashville.

Stone for locks, of excellent quality, can be found near at hand, while all other supplies, especially iron, can be obtained via Cincinnati rapidly and at the lowest possible cost.

These considerations lead to the suggestion that it may be advisable to subdivide the Cumberland River above Nashville, from Nashville to head of Smith's Shoals, Kentucky, and the appropriations for its improvement into three sections:

	Miles.
(1) In Tennessee, above Nashville	130
(2) In Kentucky, below Point Burnside	197
(3) At Smith's Shoals	10

The cost of locking and damming Smith's Shoals is estimated at $875,000, which forms a part of the present project and estimates.

(See Report of Chief of Engineers, 1882, page 1862 *et seq.*, Senate Ex. Doc. No. 132, Forty-seventh Congress, first session, and Senate Ex. Doc. No. 129, Forty-eighth Congress, first session.)

The amount available, if the pending river and harbor bill become a law, and amount herein asked for, can be profitably expended in completing Lock No. 1 at lower Nashville Island, and in procuring sites for and construction of Lock No. 2, near Beck's Ripples, about 14 miles above Lock No. 1. Also, if the plan herein recommended to carry on work in two sections—the upper one being in Kentucky—be approved, to procure site and begin the upper lock of the series, about 4 miles below Burnside, Ky., near Waitsborough.

Estimate for improving Cumberland River from Nashville to head of Smith's Shoals	$4,077,922.00
Amount appropriated	125,000.00
Amount expended	54,424.20

Money statement.

July 1, 1887, amount available		$77,611.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,408.93	
July 1, 1888, outstanding liabilities	626.46	
		7,035.39
July 1, 1888, balance available		70,575.80
Amount appropriated by act of August 11, 1888		200,000.00
Amount available for fiscal year ending June 30, 1889		270,575.80
Amount (estimated) required for completion of existing project		3,752,922.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		800,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(III). CUMBERLAND RIVER ABOVE MOUTH OF JELLICO, KENTUCKY, 110 MILES.

The conditions and estimates pertaining to this section of the Cumberland River remaining unchanged since last report, the report and recommendations therein are resubmitted:

This section was examined in 1880, and an estimate submitted for its improvement to Cumberland Ford (Pineville), the project being to give safe navigation for about four months in the year.

An appropriation of $10,000 was made for this section in 1881, and in the following year $5,000 was added, and this appropriation (1882) remains in the Treasury.

The chief obstructions are gravel-bars, snags, and eleven mill-dams.

Until the dams are bought, either by voluntary agreement or by condemnation, it appears to be impracticable to do any further work on this section.

A descriptive list of these dams is given in the Annual Report of the Chief of Engineers, 1883, pages 1491, 1492.

In September, 1886, a circular letter was sent to each of the owners of the dams, asking for the lowest price at which the dam would be sold, vesting a good title in the United States.

Replies were received from nine of the eleven owners.

The estimated values as given in the report of 1883 equal $15,250.

The lowest price asked in 1886 for the nine dams was $15,710, to which add the estimated value of Dams Nos. 6 and 9, no reply having been received, $1,350, making a probable voluntary valuation of $17,060, which appears to be reasonable.

The charter granted by the State of Kentucky, April 24, 1882, to the Cumberland River Improvement Company to build locks and dams, condemn mills, collect tolls, etc., referred to in report of Chief of Engineers, 1884, page 1649, was repealed by act approved January 24, 1884.

Should Congress not determine to continue the improvement by the necessary legislation, having in view the voluntary purchase or condemnation of these mill-dams, I would respectfully recommend that the balance be made available for expenditure upon the "Cumberland River above Nashville."

Estimate for improving the Cumberland River above the mouth of Jellico, Kentucky	$50,000
Amount appropriated	15,000
Amount expended	10,000

Money statement.

July 1, 1887, amount available	$5,000
July 1, 1888, balance available	5,000
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000

COMMERCIAL STATISTICS.

Cumberland River, below Nashville, from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Brick ... number	3,300	Salt ... barrels	6,119
Coal ... tons	259	Tobacco ... pounds	5,888,600
Flour ... barrels	6,823	Wood ... cords	17,690
Grain ... bushels	409,536	Lumber ... feet B. M.	5,805,000
Hay ... tons	243	Logs ... do	3,115,000
Iron ... do	3,384	Sand ... cubic yards	5,830
Live stock ... head	701	Merchandise ... pounds	9,777,400
Passengers ... number	5,607		

List of steam-boats plying on Cumberland River below Nashville.

Names of boats.	Length.	Breadth.	Depth.	Tonnage.
J. P. Drouillard	165	31	5	467
B. S. Rhea	162	32	4.05	203
T. Sniver	130	28	4	127
Julien Gracey	100	22	3	81
J. H. Hillman	149	29	4	281
E. G. Ragon	165	31	5	400
Jas. R. Skiles	100	22	3	41
E. T. Hollman	100	22	3	81

COMMERCIAL STATISTICS.

Cumberland River, above Nashville, from July 1, 1887, *to June* 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Brick ... number	10,100	Logs ... feet B. M.	24,791,000
Coal ... tons	79	Passengers ... number	13,463
Flour ... barrels	11,148	Sand ... cubic yards	30,830
Grain ... bushels	56,516	Salt ... barrels	4,754
Hay ... tons	104	Tobacco ... pounds	3,389,600
Iron ... do	182	Wood ... cords	730
Live-stock ... head	2,689	Merchandise ... pounds	5,843,000
Lumber ... feet B. M.	8,569,000		

List of steam-boats plying on Cumberland River above Nashville.

Names of boats.	Length.	Breadth.	Depth.	Tonnage.
Sam P. Jones	149	30	4	359
John Fowler	149	30	4	237
Matt. F. Allen	149	28	4	245
H. K. Bedford	149	27	4	139
Crusader	146	22	3	186
J. D. Carter	85	20	3	45
Pearl	140	22	3	31
Wm. Porter	149	30	4	168

SPECIAL REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, SUBMITTING PLAN AND ESTIMATE FOR LOCK AT OR NEAR THE LOWER ISLAND, AT NASHVILLE.

ENGINEER OFFICE, U. S. ARMY,
Chattanooga, Tenn., January 28, 1887.

GENERAL: Referring to Department letter of November 17, relating to the application of the appropriation of $75,000, made at the last session of Congress for improving Cumberland River, Tennessee and Kentucky, continuing improvement above Nashville with a view to secure in the channel a depth of 4 feet, commencing with the lock at or near the lower island at Nashville, I have the honor to report as follows:

Presented herewith are drawings, as desired, showing the plan and cross-section of the proposed lock and dam, and a map of the proposed site, including adjacent land on each side of the river, a part of which is required for construction purposes and a keeper's dwelling.

The lock is designed to be 50 feet wide and 250 feet long between miter-sills, and to have an extreme lift of 12 feet. These dimensions were determined after much investigation and a number of conversa-

tions with steam-boat men and others interested in the navigation of the river.

A general impression seemed to prevail that a lock even smaller would satisfy the requirements, as the steamers now in use are less than 150 feet in length and not over 30 feet in breadth; that the tows would generally be broken in passing the locks unless the latter were built of such large size as to greatly delay the whole project of improvement.

While agreeing with this view of the queston to a certain extent, I think it would be well to adopt a lock of medium size, so as to provide for possible future modification in the construction of vessels. The dimensions adopted will take in any single vessel that is likely to navigate this river, and will accomodate the two boats now in use with two and probably three ordinary barges at one lockage.

This lock, although a part of the system of upper-river improvement, being located below Nashville, must be considered also in relation to the navigation of the lower river, and as a greater depth than 4 feet, as provided in the bill for the upper river, may at some time be demanded for the lower river, I deem it proper to recommend that this lock be so built that it shall have 5 feet of water over the miter-sills.

The question of lift has been carefully considered, since the cost of the entire system will depend largely upon it as well as the convenience of navigation.

By decreasing the number of locks, and correspondingly increasing the lift, we lessen the cost of construction, but we also shorten the period of open-river navigation, which on this river is of considerable importance. Should the dams throughout be constructed about 11 feet high, vessels would be able to pass over them safely from 30 to 60 days of each year; much higher dams than 11 feet would necesssitate using the locks nearly the entirely season and would also require excessively high lock-walls.

The dam designed for the first lock will, acccording to Mr. Turrill's survey made in 1883, submerge to a depth of 4 feet all obstructions in the river as far up as the Hermitage Reef, a distance of 18 miles, which place affords an excellent site for another lock and dam.

In Mr. Turrill's report upon this survey the lift of this lock below Nashville is placed at 6.5 feet, but I am inclined to believe that he had in mind at that time the construction of a dam still lower down which would raise the water at this point about 4 or 5 feet, and thus reduce the lift and avoid a considerable excavation which I find necessary to gain the desired depth for the lock-chamber.

With dams 11 feet high and assuming a depth of 1 foot of water above the crest, the extreme lift of the locks will be 12 feet; the total fall of the river from Point Burnside to Nashville being 223 feet, the number of locks required will not exceed twenty. The lock now to be built will be located near the north shore of the river, which here presents a bold, rocky front, and will be so adjusted as to economize as far as possible the necessary excavation and embankment. The former, being largely rock, will be kept as small as practicable.

Excellent fossiliferous limestone, suitable for lock-walls has been found on the river within a distance of 15 miles and negotiations are in progress for obtaining quarry privileges.

Inferior stone suitable for the dam can be obtained much nearer the site.

A land company at Nashville has recently acquired control of most of the land on the north bank of the river in the immediate vicinity of the lock-site, including that marked as *belonging* to Mr. Nance.

The president of this company Dr. Pierce, of Nashville, stated that his company would be pleased to donate to the United States for lock purposes such land belonging to the company as might be required.

The ownership of lands on the borders of the river extends only to low water, the bed of the stream must therefore be public property. It would be desirable to accept from Dr. Pierce the ground shown on the map as the "Nance Stable lot," containing 1½ acres. This would be quite suitable for keeper's dwelling.

The river front of this piece of land is not as long as the lock, and the location determined upon places about 100 feet of the lock upon the land belonging to the Page heirs, a good title to which is said to be very difficult to obtain, as the heirs are widely scattered.

If it is found impracticable to obtain title to the Page land it is possible to move the lock down-stream a sufficient distance to avoid this land and take in the necessary additional front upon the adjoining property on the other side of the Nance lot, a title to which can be acquired from the land company.

Upon the opposite side there will be no difficulty in acquiring title to the necessary ground for the terminus of the dam—the compensation can be readily adjusted.

Accompanying are estimates in detail of the cost of the proposed lock and dam based upon the best information obtainable.

It is believed that a timber dam filled with stone can be constructed at somewhat less cost than solid masonry, but in view of the convenience of obtaining good stone near at hand and its more permanent character the latter method is deemed most advisable.

I would recommend that the work be done by hired labor and the materials purchased either by contract or in open market, as may be found more expedient, rather than by letting out the whole work by contract, for the following reasons:

(1) This being the first of a large number of locks and dams to be built on this river, I think it would be well to acquire in this way the necessary data in regard to the quality of material to be found in the vicinity and the legitimate cost of doing the different classes of work required, so that if thought proper to contract in the future more intelligent estimates can be made than is now possible.

(2) The experience had upon the Tennessee River with contract work was not such as to commend that method, and it is very doubtful if it would prove more satisfactory on the Cumberland.

As it is desirable to begin work under this project at an early day I would recommend that the necessary legislation to acquire title to such land as may be required for a site for the lock and dam, keeper's dwelling, and other purposes in connection with this work be had during this session of Congress.

In this connection consideration is asked to my separate letter of this date to the Chief of Engineers upon this subject.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

ESTIMATE OF COST OF LOCK AND DAM FOR THE CUMBERLAND RIVER AT THE SITE SELECTED BELOW NASHVILLE.

The prices are based on contract rates previously obtained for locks on Mussel Shoals Canal.

Cost of lock.

	Amount.	Cost per cubic yard.	Total.
Masonry laid:	*Cubic yards.*		
Cut stone	2,350	$13.50	$31,725
Rock faced	279	10.00	2,790
Rubble	7,209	6.00	43,254
Excavation	3,275	2.00	6,550
Filling	9,550	.50	4,775
Total cost of lock			89,094
Add coffer-dam, 600 feet, at $10			6,000
Total			95,094

COST OF DAM.

	Feet.
Length of dam of masonry	435
Average height	16
Width at base	12
Width at crest	5

Batter equal on up and down stream sides. This dam will have a coefficient of stability for still water of about 4.

Amount of masonry	cubic yards	2,191
Cost per cubic yard		$8
Total		$17,528

Its construction would require 900 linear feet of coffer-dam, at $10 ..... $9,000

Total estimate.

Cost of lock and coffer-dam	$95,094
Cost of dam and coffer-dam	26,528
Iron and steel lock-gates	5,000
Riprapping bank	2,000
Maneuvering appliances	1,000
Site and quarry privileges (estimated)	3,000
Contingencies	13,262
Total cost	145,884

LETTER TRANSMITTING REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., April 6, 1887.

SIR: I have the honor to transmit herewith the report of the Board of Engineer Officers constituted by paragraph 1, Special Orders No. 43, headquarters Corps of Engineers, March 12, 1887, "to examine and report upon the plan and estimate for a lock at or near the lower island at Nashville, for improving Cumberland River, Tennessee and Kentucky, submitted by Lieut. Col. John W. Barlow, Corps of Engineers."

The Board having recommended material modifications of the plans, the estimates submitted by Colonel Barlow *are not* applicable, and new plans with new *estimates will necessarily* have to be prepared.

As to the difference of opinion in regard to the dimensions of the proposed lock, the majority of the Board believe that those given by them should be adopted.

All their past experience teaches that the requirements of commerce have demanded enlargement of the projects originally submitted.

In this case the majority have deemed it judicious to pass at once to the dimensions adopted on other like works. They attach no importance to the opinions of the river navigators touching this question, as these very men would be the first to build larger, and therefore proportionally more economical, boats, and then blame the engineers for having failed to provide sufficient accommodation.

The papers referred to the Board are herewith respectfully returned, the tracings being in a separate package.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Senior Member of the Board.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 29, 1887.

Respectfully submitted to the Secretary of War.

The views of the Board are concurred in by this office and are recommended for approval.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *August* 2, 1887.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War.

SAMUEL HODGKINS,
Acting Chief Clerk.

REPORT OF THE BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., March 30, 1887.

The CHIEF OF ENGINEERS, U. S. A.:

GENERAL: The Board of Engineers convened by Special Orders, No. 43, Headquarters Corps of Engineers, Washington, D. C., March 12, 1887, having visited the proposed site and carefully examined and discussed the project of Lieutenant-Colonel Barlow for a lock and dam at Lower Nashville Island, Cumberland River, has the honor to submit the following report.

In its conclusions the Board has been guided by the following general considerations:

A dam, if practicable, should rest against the upper buttress of its lock, so as to have the whole length of the lock-chamber in the lower pool.

Locks should be put as far into the bank as possible in order to secure the longest possible spill. This condition, however, is not imperative at localities where the width of the river is sufficient to give a spill greater than the average.

The locks on the Cumberland River are assumed to be specially intended for the development of the coal traffic of the Upper Cumberland. To handle this traffic economically the locks should be large enough to take in a full tow with tow-boat at one lockage. For the present it is deemed best to assume as the ordinary tow one tow-boat and three barges. It is assumed that whatever be the present size of Cumberland River coal barges, they will ultimately be made to conform to the standard size in use on the Ohio and Great Kanawha rivers, which is 130 feet long and 25 feet wide. Two barges abreast will then require a width of lock of 52 feet. The length of tow-boat that will probably be used for such fleets will be 25 feet wide and 150 feet long over all. It is therefore evident that the available length of the proposed lock should be 280 feet. This length is the distance between the springing lines of the upper miter-wall and the upper end of the lower gate recesses.

The guards of all locks should be such that the fall over the dam at the epoch of the submergence of the lock-walls will not exceed 1 foot when the discharge of the river for that stage is at its maximum. If possible, without too great cost, the walls should be high enough to reduce this fall to 6 inches. To ascertain this height definitely the maximum discharges of the river for such stages should be determined by observation.

The lifts of dams should be from 10 to 12 feet, experience having shown that these are the best lifts in practice. The lowest dam of the series should have such a height as to secure the standard lift in case another dam should be built below it.

DETAILS OF LOCKS.

It is recommended that the inner walls of the lock, including the lower side of the upper miter-wall, be built without batter.

The angle between the gates when shut should be 140°, corresponding to a miter angle of 20°.

The tops of the lock-gates should be even with the lock walls in order to permit the use of the lock to the last moment.

The gates should be made as thin as possible, so as to avoid under-pressures tending to pull up the miter-sills. The same object may be attained by permitting the gate to extend partly over the sill when shut, but it is believed that, for locks of the width recommended, gates of sufficient thinness can be obtained by making them solid for about half their height.

It is recommended that the wooden sill against which the gates close be made at least two inches higher than the miter-wall, so as to act as a guard for the masonry.

The Board would recommend that the question of the material for the gates should be left open for the present until the results of experience with iron gates on other rivers be more clearly ascertained. Meanwhile they recommend that the gate recesses be built for wooden gates, as such recesses will answer for either kind.

The method of maneuvering the gates should be left to the local engineer.

The upper miter-sill should be placed 1 foot below normal depth, so as to permit the pool level to be reduced 1 foot without affecting naviga-

tion. Such reduction is often desirable in order to repair the comb of the dam.

The Board recommends that the walls be built without counterforts.

The two walls should have equal strength, but the coping of the land wall may be made narrow. The top width of the river wall should be from 6 to 7 feet.

A drainage culvert with open joints is recommended behind the land wall to carry off land water. Great care must be used to seal it against any flow of water from the upper pool.

From 2 to 4 recessed ladders are recommended for the lock-chamber, for the convenience of raftsmen and for the safety of life.

It is recommended that some cheap form of movable dam be placed across the head of the lock for use in case of accidents to the upper gates or valves.

The method of filling and emptying the lock is approved. It is recommended that the engineers have the option of filling the lock through inlets under the upper miter-sill in case he should so elect.

Movable gratings should be placed above all valves.

A guide-crib should be built on the upper extension of the river wall to a distance of about 100 feet, depending on local circumstances. Between this guide-crib and the lock-wall should be a drift gap 10 feet wide and at least 6 feet deep. At the upper end of the crib should be a pier-head about 5 feet higher than the body of the crib, with a slope on the upper side to ward off drift.

In case the land wall of the lock is extended up and down stream by crib-work, as is customary, the upper and lower wing-walls should be at right angles to the land wall, with rounded corners. In case no such cribs are built the wing-walls should be flared so as to guide boats into the lock.

The surface of the ground back of the land wall of the lock should be paved to a depth of from 10 to 12 inches, the pavement extending up the slope to the highest flood level, or to the top of the bank if below flood level.

DETAILS OF ABUTMENTS.

As a rule the abutments should be carried to a height of about 5 feet above the tops of the lock-walls and they should be built in the bank far enough not to act as spurs or jetties in time of flood. The masonry work should be extended down-stream to a distance of at least 60 feet below the lower side of the dam; but the top need not be carried to full height beyond a point half-way between the crest and the foot of the dam. Beyond this it can descend rapidly in steps to a height of from 4 to 8 feet above the low-water line below the dam, depending on the lift. This abutment should be continued at least 100 feet further by crib-work as high as the lowest step of the masonry.

DETAILS OF DAMS.

It is recommended that the dams be built of timber like those that have been in successful use on either the Monongahela or Kentucky rivers. In order to secure greater tightness, and in view of the cheapness of stone at the locality, the Board would recommend that the engineer in local charge have authority to add a masonry or concrete diaphragm or a wall on the upper side of the up-stream breast in case he should consider such an addition advisable.

LOCATION OF LOCK AND DAM AT LOWER NASHVILLE ISLAND.

The location proposed by the engineer in charge is approved in general, with the recommendation that a change of 400 feet in either direction be authorized in case more detailed examinations should make it desirable. In the opinion of the Board the axis of the lock should be so placed as to preserve a clear approach to the lock from either direction of at least 400 feet.

A depth of 4 feet on the lower miter-sills of the general system of locks and dams is in accordance with the requirements of the river and harbor act. The project submitted to the Board contemplates a depth of 5 feet on the lower miter-sill of the lock at Lower Nashville Island. The Board think that such a depth is unadvisable in this lock, because it has an open river below it. The existing low-water depth in the open river is 2 feet, but efforts will be made to increase this depth by guiding-dikes and channel excavation. Inasmuch as experience on other rivers indicates that it is improbable that this open river depth can be increased beyond 4 feet, and in order to avoid the construction and maneuvering of unnecessarily heavy lower gates, the Board recommend that the level of the lower miter-sill of the lock in question be placed at 4 feet below low water. Should other dams be built below Nashville, and a greater depth be desired, it can readily be obtained by suitable regulation of the dam next below.

Respectfully submitted,

O. M. POE.
Lieut. Col. of Engineers.
WM. E. MERRILL,
Lieut. Col. of Engineers.
H. E. WATERMAN,
First Lieut. of Engineers,
Recorder.

While I agree with most of the foregoing conclusions and recommendations, I do not think it either necessary or desirable to enlarge the size of the lock as suggested. It is not probable that the same boats used in the coal trade on other rivers will be used above Nashville, and rivermen most interested in the navigation of the Cumberland say that 50 feet by 250 feet will be large enough, as the largest barges they now have are 20 feet by 100 feet and those they expect to use will not exceed 24 feet by 120 feet. They have no tow-boats, and will not probably use any that are larger than 24 feet by 130 feet.

While uniformity is a desirable thing in such matters, I do not think it would be just to those most interested in the development of the coal trade on the Cumberland River, to build larger locks than they desire, especially as it would delay and increase the cost of the work.

Under the most favorable circumstances it will take several appropriations as large as those usually made to build enough locks and dams to enable the work to be of any considerable advantage to commerce.

As to "details of locks and dams," I would consider the recommendations of the report merely as suggestions to the engineer in charge of the work rather than as modifications of his plans, and I would respectfully recommend that he be authorized to make such changes of details as may be found desirable during the progress of the work.

As to location and lift of the first lock, I concur in the recommenda-

tions of the Board, but for other locks the lift should be such as to secure good sites for all the locks, even if the lift in some cases should exceed the limit mentioned.

Respectfully submitted,

W. R. KING,
Major of Engineers.

MOUTH OF THE CUMBERLAND RIVER.

ENGINEER OFFICE U. S. ARMY,
Chattanooga, Tenn., April 17, 1888.

SIR: In compliance with request contained in Department letter of the 12th instant, I have the honor to present the following report upon the present condition of navigation at the mouth of the Cumberland River.

The last survey or special examination at this locality was made in December, 1884. At that time navigation had been improved by the construction of two spur-dams and channel excavations, in compliance with the recommendation of the Board of Engineers, which made a report under date of September 30, 1881.

The object of the dams seems to have been to close at low water the channel between Cumberland Island and the tow-head, and deflect the current through the channel along the Kentucky shore. This work was beneficial, as but little complaint was heard during the next three seasons. But the works as constructed have not proved entirely successful, late reports showing that the channel has again been divided, and a portion of the current passes to the right of the tow-head along Cumberland Island. It is also reported that the left channel has been obstructed by the caving of the Kentucky bank. To this cause is probably due the deflection of a portion of the current to the right of the tow-head which the dams were intended to prevent.

The Board of Engineers, in their report, recommended for temporary relief the scraping or dredging of the bottom, and the brush and stone dams above referred to, and also advised a detailed survey upon which to base a permanent improvement. The survey was made under Major King's direction, but I find no record of any permanent plan of improvement based upon it, and no record of any further consideration of the subject by the Board.

It appears from its history that this improvement has always been a difficult question on account of its peculiar relation to the Ohio River, the obstructing shoal being actually in the south or Kentucky Channel of the Ohio, and more than a mile below the mouth of the Cumberland. At an early period this channel was the best navigable channel of the Ohio, made or kept so by a dam in the Ohio River above Cumberland Island, and recommended by Captain Delafield in 1833, the object of the dam as stated by him being "to throw the low-water channel to the left of the island to *avoid* a shoal bar near the lower point of the island."

Under more recent projects for the improvement of the Ohio, this dam has been removed, for the reason as stated by Colonel Merrill, that "the dam has failed to secure the result indicated as there has always been a bad bar at the foot of Cumberland Island." It seems probable that this is the identical bar which Captain Delafield, by carrying the channel to the left of Cumberland Island, intended to *avoid* rather than to remove.

This improvement seems to be one of joint importance to the two rivers, and if a plan can be devised which by improving the Kentucky

Channel of the Ohio as was originally intended, and thus the obstructions to navigation in both rivers overcome, it would seem more desirable to carry out such a plan than to improve the two channels under separate plans.

Under present conditions since the removal of the Cumberland Island Dam the supply of water in the Kentucky Channel of the Ohio is not sufficient ts give the needed scour on the bar near the foot of the island. It is manifest, therefore, that one of two methods must be employed to produce permanent improvement. First, to rebuild the dam at head of Cumberland Island and make this the navigable channel of the Ohio as was designed in 1833; or, second, to improve the channel for the needs of the Cumberland navigation only, by constructing a low-water channel through the bar sufficiently contracted to insure its being kept open by the effect of scour from the Cumberland River alone.

A further examination of the locality to ascertain the changes that have occurred since the last survey will be necessary to prepare a complete project for either plan of improvement, but from information now at hand it is estimated that the sum of $20,000 can be profitably expended in continuing work under the existing project, and would include repairing and extending the dams now considerably damaged, dredging on the bar, and such shore protection as may be necessary to prevent the banks from caving, the latter being in addition to the existing project, and in accordance with the second plan above mentioned.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 20, 1888.

Respectfully submitted to the Secretary of War.

In view of the statement within made by Lieut. Col. J. W. Barlow, Corps of Engineers, in reference to the difficulties which arise as to the best method to be adopted for the improvement of the navigation at the Cumberland River, where it joins the Ohio River, it is deemed advisable that the subject be referred to a Board of Engineers, to consider and recommend a plan of improvement which will, as far as practicable, provide for the interests of navigation of both these rivers, and I have accordingly to recommend that a Board be convened for the purpose, to consist of the following-named officers of the Corps of Engineers, viz: Lieut. Col. William E. Merrill, Lieut. Col. John W. Barlow, and Maj. Alexander Mackenzie, with Lieut. H. E. Waterman as recorder, to meet at Chattanooga, Tenn., upon the call of the senior member, at such time as the other duties of the members will permit. * * *

If approved by the Secretary of War the order convening the Board will be issued from this office.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *April* 23, 1888.

The recommendation of the Chief of Engineers is approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

JUNE 16, 1888.

The CHIEF OF ENGINEERS, U. S. A.:

GENERAL: The Board of Engineers constituted by "Special Orders No. 22, Headquarters Corps of Engineers, April 26, 1888, for the purpose of considering and recommending a plan for the improvement of the navigation at the mouth of the Cumberland River," met at Chattanooga, Tenn., on May 9, 10, and 11, and on May 14 made a personal examination of the Cumberland River, in the vicinity of its mouth.

Having considered all the information attainable, the Board respectfully presents the following report:

The Cumberland River enters the main channel of the Ohio near the foot of Cumberland Island. Near the foot of this island the channel widens, and is divided by a tow-head, and at certain relative stages of the Ohio and Cumberland rivers, eddies and slackwater are produced, which result in the deposit of sedimentary matter, and the formation of changeable gravel, sand, and mud bars about and above this tow-head. Under these conditions of wide bed and divided channels, the current of the Cumberland River, as a rule, has not sufficient scouring power at low water to remove the deposit or cut out a good navigable channel on either side of the tow-head.

The records show that the conditions here described have always existed, and with the return of each low-water season navigation at the foot of Cumberland Island has been more or less obstructed.

A Board of Engineers was assembled in 1881 "for the purpose of taking into consideration the immediate relief, and also the subject of the permanent improvement, of the navigation of the entrance into Cumberland River, with the view of determining upon a plan of improvement, etc." Under date of September 30, 1881, this Board made a preliminary report which recommended "that the officer in charge of the improvement of the Cumberland River be authorized to deepen the existing channel at the foot of Cumberland Island by scraping, dredging, small brush-dams, or similar expedients as may seem to him best."

A detailed survey, upon which plans of permanent relief could be based, was also recommended.

The Board stated:

> It will probably be necessary to close one of the two channels at the foot of Cumberland Island, which are separated by the tow-head, but the selection of the channel to be closed can not be intelligently made until above-named map is prepared.

In September, 1881, a little scraping on the bar was attempted without much success, and in October and November the survey recommended was made.

Subsequent to the survey no further action was taken by the Board of 1881, and no plans for permanent improvement were prepared.

During the year 1882 a temporary brush-dam was built from the Cumberland Island share, with a view to confining the low-water channel between the tow-head and the Kentucky shore, and in 1884 a second dam above the first was constructed and further scraping was done.

Some good resulted from the work, and a channel 2 feet deep at low water was secured for a time. But the dams were not of sufficient size or stability, or so located as to permanently maintain the channel between the tow-head and the Kentucky shore, and the conditions existing previous to the construction of the dams have reappeared; it is now reported that boats wishing to ascend the Cumberland will experience trouble when the stage of water is less than 4 feet.

The instructions to the present Board require that they give the sub-

ject the consideration that its importance demands and recommend a plan of improvement which will, as far as practicable, provide for the interest of navigation of both the Ohio and Cumberland rivers at the locality mentioned."

A letter addressed by Lieut. Col. J. W. Barlow, Corps of Engineers, to the Chief of Engineers, under date of April 17, 1888, which letter is submitted to the Board for its information and consideration, contains the following:

This improvement seems to be one of joint importance to the two rivers, and if a plan can be devised which by improving the Kentucky Channel of the Ohio, as was originally intended, and thus the obstructions to navigation in both rivers overcome, it would seem more desirable to carry out such a plan than to improve the two channels under separate plans.

The joint improvement of the Ohio and Cumberland was attempted many years ago by the construction across the main channel of the Ohio of the "Cumberland Dam," with a view to forcing all the water of the Ohio, at low stages, through the chute at the head of Cumberland Island.

A brief history of this dam and the results are given in the following extract from the report of Lieut. Col. William E. Merrill, Corps of Engineers, the officer in charge of improving the Ohio River (report of the Chief of Engineers, 1876, pages 23, 24):

The repair of this dam was evidently ordered on the strength of my report of February 14, 1872, printed as House Ex. Doc. No. 165, Forty-second Congress, second session, and reprinted in Report of Chief of Engineers for 1872, pages 409–412.

This report gives a full history of this dam, and to it I would respectfully refer for additional information. The dam was begun in 1832, and partly finished; repaired and completed in 1838; partly repaired in 1854; and thoroughly repaired and completed in 1872–'74. Since 1874 it has rarely been out of water, but a recent letter from the former inspector of reconstruction informs me that there has been some subsidence in the new part of the dam, connecting the old dam with the head of Cumberland Island, but that the main dam stands firm.

In recommending the repair of the Cumberland Dam I naturally assumed that the only question involved was that of the permanence of the work, and that if we could make the dam stand, the results which were originally sought, and which seemed from old reports to have been attained as long as the dam was in good condition, would reappear. Feeling confident that the dam could be made reasonably permanent, and believing this to be the only question involved, I therefore recommend its repair.

Experience shows that the dam has been made sufficiently durable, but that the result is unfavorable from an unforeseen cause. The difficulty is due to the fact that at high water, when the dam is so deeply submerged as not to affect the current, the main volume of the river crosses the dam, while the Kentucky Chute is in comparatively still water, and receives heavy deposits of sedimentary matter. As the river falls the influence of the dam begins and gradually increases, and its ultimate effect is to force a strong current through the Kentucky Chute, washing out the deposits of high water and creating a navigable channel. If the river falls very slowly this channel can be washed out in time to prevent any injury to navigation; but, if the fall is sudden, or if the Cumberland is in flood and backs up the Ohio, there is not time enough to do this scouring work, and for a period of uncertain length there is no channel either over the dam or through the chute. This, I think, explains fully the present difficulty at Cumberland Dam.

* * * * * * *

Under these circumstances, I think that the Cumberland Dam has survived its usefulness and should be removed. This can be easily done during the low water by the United States dredge-boats, and the material can be advantageously used in improving the channel at the foot of the island and in keeping open the natural mouth of the Cumberland River.

* * * * * * *

The officer in charge of the improvement of the Ohio River states that since the removal of the Cumberland Dam, Ohio River commerce has not been obstructed or delayed by low water in the vicinity of Cumberland Island, and that the present condition of affairs is perfectly satisfactory to Ohio River commerce. As the dam was removed in 1878, the experience of about ten years is conclusive on this point.

It is the opinion of the Board that the Ohio River in the vicinity of Cumberland Island now occupies its natural channel, and that it will not without forcing make use of the Kentucky Chute; also, that for the past ten years at least, there has been no trouble to Ohio River navigation at this point; and that no work is at present required for the improvement of the Ohio in this locality.

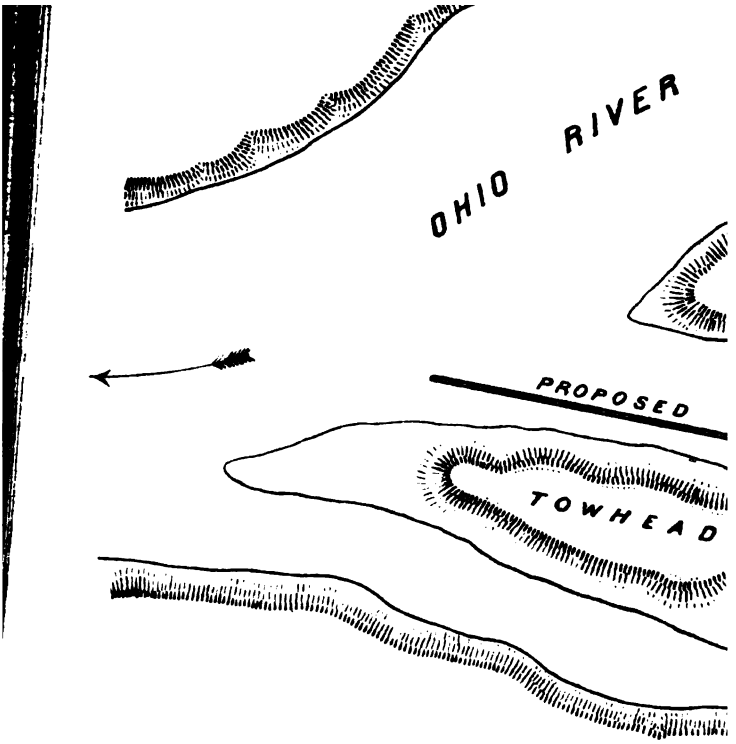
It further appears that Cumberland River navigation is most seriously affected by the condition of the channel at the foot of Kentucky Chute through which the Cumberland River reaches the main channel of the Ohio. This obstruction is so great as to, at times, entirely block commerce of very great importance to a large territory, and it is most proper that some steps be taken immediately to relieve the commerce of the Cumberland River.

The trouble existing at the foot of the Kentucky Chute results from the fact that the volume of the Cumberland is not sufficient, when allowed to take its natural course, to wash out and maintain a channel at the foot of the chute, where heavy deposits are made in the slackwater resulting from the division and spreading of the channel and the meeting, at certain stages, of the waters of the Cumberland and Ohio.

The confining, to its proper limits, of the channel at the foot of the chute, must form a part of any plan of improvement demanded by the joint interests of the Cumberland and the Ohio, and such work may be sufficient for forming and maintaining a navigable channel at the junction of the two rivers. It is evident, therefore, that before any other methods of improvement are discussed, it is first necessary to see if a good, navigable channel can not be made at the foot of Cumberland Island by closing one of the two outlets and so contracting the other that the ordinary flow of the Cumberland will keep it open. This is the natural proceeding in like cases, and as it has never been tried in this locality, it is evidently the work that nature and experience indicate.

After a careful examination of the locality, and consultation with Cumberland River navigators, the Board is of the opinion that the channel between Cumberland Island and the tow-head is the better of the two for a permanent mouth. The facts that it is now the better channel, notwithstanding the work expended in endeavoring to close it; that it is the shorter line to deep water in the Ohio; and that the Kentucky bank along the other channel is soft and caving, all combine to re-inforce this conclusion.

The Board therefore recommends that the left channel be closed by a pile and brush dam, skirting the upper side of the tow-head, parallel to the south shore of Cumberland Island, and that the interval between the dam and the island be provisionally taken at the normal width of the lower part of the Cumberland River. This dam should connect with the Kentucky shore by an easy curve, and should be extended to deep water in the Ohio; so much of the present dams at the foot of Cumberland Island as interferes with the proposed channel should be removed. The proposed dam should be about 20 feet in width, should rise to the level of low water, and should be capped by a crib-work having a width of 12 feet and built up to the 8 foot stage. This superstructure may, at the discretion of the local engineer, be built in the season following the construction of the substructure. It is believed that the height indicated is the minimum for an effective dam in this vicinity, and experience may prove that the dam ought ultimately to be raised to a greater height. It is not practicable to settle this point in advance, and therefore the Board would further recommend that the effect of the dam be



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nd that the local engineer be authorized to increase
e experience of one or more seasons indicate such a

is called to the junction of the dike with the Ken-
y called the "root" of the dike, which should be
d from the scouring effect of the eddy caused by the
of the softness of the Kentucky bank it is recom-
bank protection be put in place before the dike itself
per face of the dike should be riprapped as a precau-
tudinal scour.
lered advisable to do more at present than to fix the
proposed permanent mouth. The conditions that pre-
y are so various that it is deemed best to limit the
such work as is clearly necessary, leaving accessory
er side of the channel to be determined after the ex-
more seasons has eliminated from the problem many
at are now undetermined. It seems clear, however,
between the dike and the island should not be allowed
hat any tendency to scour along the foot of Cumber-
d be prevented by suitable works of protection. With
e Board is of the opinion that the completion of the
should be left to the local engineer.
e proposed pile and brush dam with crib superstruct-
4,800 linear feet, which, at $27 per foot, the cost of
where, gives the estimated cost as $129,600. To this
e cost of protecting the bank of Cumberland Island, if
ecessary, but as the quantity needed, if any, can not
d, no estimate of cost is submitted.
uctions now existing in the Kentucky Chute are ob-
nberland River navigation, the Board would further
whatever work may be carried out for the removal of
is point be considered as an improvement of the Cum-
d chargeable against the appropriations for improving

wing the mouth of the Cumberland River, the Ken-
ine of the proposed dam, etc., accompanies this report.
bmitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.
J. W. BARLOW,
Lieut. Col. of Engineers.
A. MACKENZIE,
Major of Engineers.
H. E. WATERMAN,
First Lieut. of Engineers,
Recorder.

WS OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS.

with the other members of the Board to the report as
dersigned begs to offer additional views which seem to
t to the subject-matter under consideration, and which,
if forming a part of the above report, would have made
omplete, and decisive.
of the *junction of the* Cumberland and Ohio rivers

should be definitely settled by competent authority to avoid future conflict of interests.

Geographically, the Ohio in this vicinity has two channels, separated by Cumberland Island; the one now used by Ohio River commerce, being the larger, is known as the main channel; the other, for several years made navigable by the Cumberland Dam, is known as the Kentucky Chute.

The Cumberland enters the latter channel of the Ohio near the head of Cumberland Island, and after passing through the lower portion of the Kentucky Chute joins the main channel of the Ohio below the foot of that island.

The obstructions to navigation at or near the mouth of the Cumberland are therefore, *de facto*, in the Kentucky Chute of the Ohio, but since they do not obstruct the present navigation of that river their removal should, in equity, form a part of the Cumberland improvement, as recommended by the Board; but to avoid in the future any misunderstanding or delay, the mouth of the Cumberland should be authoritatively declared to be at the foot of Cumberland Island, or, in other words, that the Kentucky Chute of the Ohio shall be considered as a continuation of the Cumberland River, for the purposes of this improvement.

(?) In view of the fact that the Kentucky Chute is very wide, when compared with the Cumberland River, and that the volume of the latter, as compared with the Ohio, is very small, it is by no means certain that any plan which does not include the turning into the Kentucky Chute of a greater quantity of water than is supplied by the Cumberland River itself will prove perfectly successful, or even sufficient to give the needed relief at the entrance to the Cumberland River; while upon the other hand it appears from the information now attainable that during the existence of the Cumberland Dam, which forced a large portion of the Ohio River through the Kentucky Chute, there was no obstruction to Cumberland River navigation in this part of the channel.

It further appears, from information given by citizens of the locality, that the interruption to Ohio River commerce due to the Cumberland Dam was not of a serious nature, and that the delays from causes given by Colonel Merrill would probably have been still less had the Dog Island Chute been also closed.

Looking at this question from the standpoint of Cumberland River interests, it is manifest that if the closing of the main channel of the Ohio at low water is the only method by which navigation at the entrance of Cumberland River can be maintained, the Cumberland Dam should be restored, as the commerce of Cumberland River has the right of existence, even at the cost of some inconvenience to that of the Ohio.

In regard to the construction of the proposed dike closing the left channel of the Kentucky Chute, I am of the opinion that the reconstruction of the Cumberland Dam would cost less and would more surely accomplish the desired result, but since the latter would somewhat inconvenience Ohio River commerce, as a concession to that interest, I am willing to agree to the experiment of building the dike, upon the distinct understanding, however, that should the result prove unsatisfactory to Cumberland River navigation, then the Cumberland Island Dam should be restored and the Dog Island Chute should be closed.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col. of Engineers.
H. E. WATERMAN,
First Lieut. of Engineers,
Recorder.

A A 8.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

This stream is formed by the junction in Tennessee of Clear Fork and New River, and after a northerly course of about 88 miles discharges into the Cumberland River near Burnside, Ky., 2 miles below Smith's Shoals.

An examination was made in 1881, and the obstructions were found to be principally immense sandstone bowlders in its upper course, which can only be taken out at an enormous expense, and rock-reefs, gravel bars, etc., in its lower waters.

The present plan provides only for the improvement of the channel below the "Devil's Jumps," a distance of about 44 miles from the mouth of the river, by reducing the bars and reefs and building wing-dams to contract the water-way, so as to obtain a safe channel for navigation at stages of the river when at least 3 feet above low water.

Work was in progress at the close of the last fiscal year and was continued until September, 1887, at Sloan's Shoals, 7 miles, and Roberts' Mills Shoals, 16 miles, from mouth of the river.

Location.	Quarrying riprap.	Dams.	
		Spur-riprap.	Longitudinal.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
Sloan's Shoals	407	662	1,119
Roberts' Mills Shoals	200	.....	213
Total	607	662	1,332

As stated in the Annual Report for 1887, the commerce of this stream consists principally of logs in rafts, but it is very difficult to get any data pertaining to the rafting, lumber, or coal interests of sufficient definiteness to be classed as "commercial statistics;" such data, however, as could be procured is submitted.

The appropriations of 1882, 1884, and 1886 for this work, aggregating the sum of $12,000, have been expended in clearing and deepening the channel of the lower river and improving the water-way to a limited extent. Much work remains to be done to secure the advantages to commerce and navigation sought to be obtained under the present project.

The heavily timbered lands and immense coal-measures through which this river passes give abundant promise of a large river commerce when this stream offers a safe passage for rafts and flat-boats on the annual "rain tides."

In the river and harbor bill, now pending before Congress, is an item of appropriation for this work. Should that bill become a law, the amount appropriated, if any, and the amount herein asked for, can be profitably expended in continuing the work below the "Devil's Jumps," as provided for under the existing project.

Estimates for improving South Fork of Cumberland River.

From Kentucky Line to "Devil's Jumps"	$27,538.00
From "Devil's Jumps" to mouth of South Fork	35,265.00
Total for improvement in Kentucky	62,803.00
Amount appropriated	12,000.00
Amount expended	11,968.94

Money statement.

July 1, 1887, amount available		$1,877.36
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,836 33	
July 1, 1888, outstanding liabilities	9.97	
		1,846.30
July 1, 1888, balance available		31.06

Amount (estimated) required for completion of existing project	50,803.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A A 9.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

The Caney Fork River rises on the western slope of the Cumberland Mountains, and, after a westwardly course, discharges into the Cumberland River 120 miles above Nashville, Tenn. It is about 200 miles long, and flows wholly in the State of Tennessee.

The head of navigation is usually held to be at Sligo, Tenn., about 72 miles from the mouth of the river, but it can be readily extended to Frank's Ferry, about 20 miles above Sligo.

The State of Tennessee did some work in this stream, in view of its improvement, between 1830 and 1846, and also in 1860, in the vicinity of Frank's Ferry (DeKalb County).

Examinations were made in 1879 from its mouth to Sligo, and in 1886 from Sligo to Frank's Ferry. Upon these examinations the present project is based.

The obstructions throughout the 92 miles are similar in character, consisting of gravel bars, crooked channel, bowlders, snags, and overhanging trees.

The present plan of improvement is to remove the surface obstructions and build the necessary wing-dams and training-walls, so as to obtain sufficient water for safe navigation for steam-boats drawing not more than 3 feet during the usual boating season, from February to July, as high as Frank's Ferry.

Active operations were carried on during the months of July, August, and September, clearing the channel of surface obstructions and building riprap dams.

The excavation of sand, gravel, rock, etc., was principally at James' Shoals, William's Shoals, Branch Island, Hall Rock, and Trousdale Ferry. Riprap dams were built or repaired and extended, at Mine Lick Island, Indian Creek, Hickman's, William's Branch, and Trousdale's Ferry.

The snagging force worked through from Sligo to the mouth of the river, removing a large number of snags, stumps, and overhanging trees, and clearing the island chutes of willow-brush, drift, etc.

Location. Channel work.	Excavation, cubic yards.			Quarrying riprap stone, cubic yards.	Dams.		Snag-boat.		
	Solid rock.	Loose rock.	Sand and gravel.		Spur riprap, cubic yards.	Length, feet.	No. of snags removed.	No. of trees cut down.	No. of willows cut.
From Carthage to Sligo Ford	15	32	1,505	593	493	568	219	4,151	22

Near the mouth of Bluff Creek, an affluent of the Caney Fork, certain contractors for the construction of the Nashville and Knoxville Railroad wasted the excavated material from their "cuts" by throwing it into the river. On representation from this office, the company ordered this practice to be discontinued; some of the bowlders, stone, etc., so placed have been removed from the channel, but no final report has been received that the entire removal has been effected.

The commerce of the Caney Fork River is considerable; for the river forms the principal highway through which the people of that section of the State reach a market. It is very difficult to obtain data sufficiently trustworthy to tabulate as "commercial statistics," as the shipments are usually on flat-boats. A great many logs in rafts reach the Nashville market. The light-draught steam-boats plying on the Cumberland River make trips up the Caney Fork during the boating season.

The character of this stream is such that a small annual outlay will be necessary to maintain the channel in a safe navigable condition, by promptly removing the snags, logs, drift, etc., brought down by the yearly floods.

Any funds that may be made available by the river and harbor bill now pending in Congress, and the amount herein asked for, can be profitably expended in continuing the work of improvement as projected; that of securing a safe navigable channel for rafts, flat-boats, and light-draught steamers, from the mouth of the river to Frank's Ferry, during the boating season.

Estimate for improving Caney Fork River, Tennessee, from its mouth to Frank's Ferry	$45,228.00
Amount appropriated	20,000.00
Amount expended	19,421.95

Money statement.

July 1, 1887, amount available		$2,510.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,913.93	
July 1, 1888, outstanding liabilities	19.00	
		1,932.93
July 1, 1888, balance available		578.05
Amount appropriated by act of August 11, 1888		2,500.00
Amount available for fiscal year ending June 30, 1889		3,078.05
Amount (estimated) required for completion of existing project		22,728.00
Amount that can be profitably expended in fiscal year ending June 30, 1890. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

mouth of the West Fork, Tennessee," is, [redacted]
provement," based upon the following reasons, viz:

(1) The Obey's River, running through a section o
bly destitute of railway facilities, is the natural and on
way for the transportation of the heavy products of its
and the return of merchandise and supplies.

(2) That, though the work heretofore done did n
Barnes' Landing, the estimates and project of 1879 tr
as the head of navigation, yet boats have ascended at
of the river to the Forks of Obey's—*i. e.*, the mouth of

(3) The section of river sought to be surveyed—abo
the same character generally as the lower 43 miles, fo
ations have been made and expended; and if surve
would be only an extension of a work heretofore au
gress, and would subserve the agricultural and timbe
region.

Should the Chief of Engineers direct the making
would state that it will require about $250 to make th
survey and to prepare a project, with estimate of cost
ment which would then be under consideration.

Very respectfully, your obedient servant,

J. W.
Lieut. Co

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

EXAMINATION OF OBEIL'S [OBEY'S] RIVER FROM TE
IMPROVEMENTS HAVE HERETOFORE BEEN MADE
OF THE WEST FORK, TENNESSEE.

ENGINEER OFFICE, UNITED STA
Chattanooga, Tenn.,

The project for the improvement of this river below Barnes' Landing was completed in September, 1883, since which time no work has been done in the channel.

The character of this stream is such that a small annual outlay is necessary to maintain the clear, navigable channel secured in 1883, and if any such work is provided for it would be advisable that the improvement be extended to the mouth of the West Fork, so as to facilitate the passage of rafts and flat-boats, at an additional estimated cost of about $5,000, which should be appropriated at one time, so that the money be made available for expenditure during a single working season.

The present demands of commerce, which are largely those of the log and lumber-rafting interests, might be met by simply clearing the channel below Barnes' Landing of surface obstructions brought down by the floods of the past three years, but its prospective demands, based upon the large undeveloped coal measures lying along its upper waters, would indicate that this river is worthy of improvement at least to the mouth of the West Fork.

Any further appropriation for improving Obey's River, Tennessee, should be held, expressed or implied, as available for work upon that stream to the mouth of the West Fork, as far as the interests of commerce and navigation can be subserved.

The report of the assistant engineer, W. C. Crozer, is transmitted herewith.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. W. C. CROZER, ASSISTANT ENGINEER.

BURNSIDE, KY., *June* 26, 1887.

COLONEL: In compliance with your instructions dated 10th instant, I have made an examination of Obey's River from the point where improvements have heretofore been made to the mouth of the West Fork.

The point designated as the mouth of the West Fork is commonly known as the "Forks of Obey's River;" from here to the mouth it is called Obey's River, while above, the tributaries are known as the East Fork and the West Fork. The East Fork is the larger of the two, being large enough 30 to 40 miles above to float rafts out.

At the Forks, high water of 1859 was 34 feet above low water, and on March 7, 1887, it was 25 feet, while a rise of 20 feet is not at all uncommon, there being about an average of four such rises per annum.

The river at the time of the examination was about 8 inches above extreme low water, which was quite favorable for observing all of the obstructions, which consist of islands (which are only bars except in high water), overhanging trees, a few snags, loose rock, and fish-trap dams.

The river is about 150 feet wide, has considerable fall, and in high water must have a rapid current.

At present this portion of the river, and in fact all above the mouth of Wolf River, is used only for rafts of saw-logs and lumber, as many as sixty of which have been counted passing Barnes' Landing in one day. The steam-boats do not run above the mouth of Wolf River, none having gone as high as Barnes' Landing for eight or nine years. Unless the mining and shipping of coal is begun, there is but little or no need of any improvement, as the rafts can be safely run in the present condition of the river. That the coal along this river would be mined and shipped if the navigation was improved there can be no doubt, as this is the nearest coal to Nashville, and with its superior quality and easy access to the river, and water transportation all the way to Nashville, it certainly is such an advantageous position for mining, that capital will not let it lie idle much longer.

The following tabulated statement will show the position of the obstructions, what they are, and the proposed *improvement:*

The estimated cost of completing the work so far as to enable coal boats to pass out with safety, is as follows:

Dredging gravel, 2,250 cubic yards, at 75 cents	$1,687.50
Riprap dams, 750 cubic yards, at $2.50	1,875.00
Rock excavations, 40 cubic yards, at $1	40.00
Cutting overhanging trees and snags	250.00
	3,852.50
Contingencies, etc	500.00
Total	4,352.50

During the past year run-logs and lumber, valued at $60,000, have been shipped from above Barnes' Landing.

During the same period there has been shipped out of the entire river:

55,000 saw-logs, average value, each $5	$275,000
Lumber, estimated value	50,000
400 hogsheads of tobacco, at $75	30,000
Wheat, corn, and other produce, probable value	75,000
Total	330,000

The estimated cost of the work is on the presumption that the entire work will be done in one season.

Respectfully,

W. C. CROZER,
Assistant Engineer.

Obstructions and proposed improvement.

Location.	Distance from Forks of Obey's.	Length.	Least depth.	Fall.	Obstruction.	Improvement.	Quantities.
	Miles.	*Feet.*	*Feet.*	*Feet.*			*Cu. yds.*
Eastport Island	0.06	150	1.25	3.0	Bar on right	No work required	
Dewes Bar	0.25	300	1.25	1.25	do	do	
Lacey's Fish-trap	0.75	100	1.25	1.0	Loose rocks	do	
Nancy Smith Island	1.75	1,500	1.0	5.5	Bar on left	Cut brush off head of island.	
Lower Nancy Smith Island.	2.5	250	1.0	2.0	do	Cut brush and dredging.	450
Cronch Rock Shoal	2.75	400	1.0	2.5	do	do	250
Reagan Shoal	3.2	50	1.0	1.25	Loose rocks	No work required	
Winningham's Upper Bar.	3.5	100	0.75	1.25	Bar on right	do	
Winningham's Ford	3.8	300	0.75	1.25	Loose rocks	do	
Winningham's Lower Bar.	4.0	150	0.75	1.25	Bar on right	Cut brush off head of bar.	
Winningham's Island	4.6	400	1.25	2.5	Island on left	Cut brush off head of island.	
Winningham's Tuck	4.8	600			A big eddy	Two snags to cut	
Taylor's Ford Island	5.75	600	1.0	4.5	Bar on left and snags on right in channel.	Two large snags to cut.	
Lick Branch Bar	6.0	400	1.0	3.0	Bar on right, sharp bend to left.	Cut timber off left bank.	
Taylor's Rock	6.4				No obstructions		
Garrett's Shoal	7.4	150	0.75	2.5	Gravel-reef	200 feet riprap dam. Dredging	300 450
Franklin Creek Shoal	7.6	200	0.75	1.5	do	Dredging	300
Auroneet Ford	7.75	300	1.0	3.0	Bar in middle of river.	Dredging 200 feet riprap dam.	300 300
Smith's Fish-trap	8.2	150	1.0	1.5	Loose rocks	Rock excavation	20
Smith's Shoals	8.3	150	1.0	0.75	No obstruction		
Tate Rock	8.4	50	1.0	0.5	do		
Smith's Island	8.5	400	1.25	3.0	Gravel-bar	100 feet riprap dam. Dredging	150 260
Shady's Sand Bar	10.25	150	0.75	3.0	do	Dredging	100
Booker's Fish-trap	10.95	250	1.0	1.0	Loose rocks	Rock excavation	20
Booker's Ford Island	11.15	2,500	1.0	4.0	Overhanging trees.	Cut brush off left bank.	
Hurricane Bar	12.75	100	0.75	1.0	Gravel-reef	Dredging	200
Barnes' Landing	13.25						

A A 11.

PRELIMINARY EXAMINATION OF BEAR CREEK, MISSISSIPPI [BIG BEAR CREEK, MISSISSIPPI AND ALABAMA.]

ENGINEER OFFICE, U. S. ARMY,
Chattanooga, Tenn., March 12, 1887.

SIR: In compliance with letter dated office Chief of Engineers, March 2, 1887, I have the honor to report that Bear Creek, Mississippi (Big Bear Creek, Mississippi and Alabama), is, in my opinion, "worthy of improvement," based upon the following reasons, viz:

(1) This stream is the natural and at present only available outlet for the heavy trade in logs and lumber and other products of the counties of the States of Mississippi and Alabama through which it flows, and seeking the navigable waters of the Tennessee River at Eastport, Miss.

(2) The improvement, if extended to a distance of some 30 or 35 miles from its mouth, would provide for the present demands by greatly benefiting the passage of rafts and flat-boat navigation, and thus tending to provide for the prospective increase of commerce of a like character.

Should the Chief of Engineers direct the making of a survey of this stream under the provisions of the act of August 5, 1866, it would require about $400 to make the survey and prepare a project with estimates of cost for the improvement; and that no further allotment of funds would be necessary to my credit, as that sum is now in my hands and available for "examinations, surveys, and contingencies of rivers and harbors."

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF BEAR CREEK, MISSISSIPPI (BIG BEAR CREEK, MISSISSIPPI AND ALABAMA.)

ENGINEER OFFICE, U. S. ARMY,
Chattanooga, Tenn., October 27, 1887.

SIR: In compliance with instructions of the Chief of Engineers, dated February 21, 1887, I have the honor to submit the following report on the survey of Bear Creek, Mississippi, made under the provisions of the river and harbor act of August 5, 1886.

Bear Creek, or Big Bear Creek, but by act of legislature now known as Bear River, rises in northwest Alabama, passes through northeast Mississippi, and discharges its waters into the Tennessee River near Eastport, Miss.

This stream was surveyed in 1875, having in view its use as a navigable water line between the Tennessee and Tombigbee rivers, and was re-examined in the winter of 1881–'82 in compliance with act of March 3, 1881.

The present examination was made from Southard's Ford to the mouth of the river, a distance of about 30 miles.

Above the ford a reconnaissance for a distance of 5 miles was made. The river became more and more rapid as it was ascended, assuming the character of a mountain stream. The bed, instead of being largely

not appear of sufficient importance, either present
warrant any great outlay for its improvement.

By reason of its physical characteristics, its alluvi
security of lock foundations, etc., it is not deemed a
mend or discuss the radical improvement of this ri
dams, necessarily at an expense greatly in excess c
prospective value of its commercial interests, and c
navigation. However, the region around its head
be heavily timbered, and the river is the most avail
channel be sufficiently improved.

It is reported that a large part of the logs rafte
wrecked before reaching the mouth of the river; th
deemed advisable to give relief to this class of navig
the channel from Southard's Ford to the mouth of th
obstructions, loose rock, snags, fish-traps, and overh
the construction of the necessary riprap dams to co
the channel at certain points, thus securing at m
water a fairly safe channel for the passage of log-raft
the Tennessee River during a period of about eigh
year.

The cost of such improvement would be about $5
Congress decide to undertake the work $40,000 coul
pended yearly until its completion.

A small annual outlay will be necessary to maintain
being placed in the navigable condition as projected.

The report of First Lieut. H. E. Waterman, Corp
local charge of the survey, is hereto attached, accom
in eleven sections.

Respectfully submitted.

J. V
Lieut. (

The CHIEF OF ENGINEERS, U. S. A.

I forward herewith a map* of the river in eleven sections.

(1) I also inclose a table of obstructions and shoals, showing their nature and the improvements necessary to secure navigation above low water.

The total estimates for this kind of improvement are as follows:

Cutting, etc., 877 overhanging trees	$1,500
Cutting 1,000 snags	1,500
Riprap dam (11,930 cubic yards)	36,000
Sundry improvements	2,500
Equipment	2,000
Contingencies, damages to property owners, etc	6,500
Total	50,000

This improvement will probably only be temporary, since new channels can be easily formed through the low bottom lands which border the stream throughout nearly all the distance examined. Navigation, if improved in accordance with these estimates, would be confined to mean stages of water. At high water the river leaves its banks to such an extent that rafts or boats could hardly keep the channel.

(2) Estimate for slackwater navigation, 3 feet allowed at all periods.

The total fall of the river in pools and shoals from Southard's Ford to the Tennessee River is 65 feet. To overcome this fall probably eight locks and dams would be necessary.

ESTIMATE OF COST.

Eight locks and dams	$480,000
Damages to property	15,000
Removal of existing obstructions	5,000
Total	500,000

This kind of improvement is very difficult to estimate on, for the following reasons:

(1) The bottom lands are of such great extent that it would be almost impossible to prevent water from working around the dams.

(2) It would probably be impossible to secure a rock foundation for the lock-walls, thus requiring an expensive artificial floor to each lock, with the chances of constant leakage and eventually undermining.

(3) The commerce of the section of country bordering on this stream is very little, and it was difficult to determine its exact amount. Nearly all the timber near the river below Southard's Ford has been cut down. It is estimated that 500,000 feet, B. M., of logs were rafted down the river last year, of which a large part was wrecked before reaching the river's mouth.

Of other commerce we could find no evidence, and in consequence I hardly think either of the two mentioned kinds of improvement advisable.

As to the character of Big Bear Creek above Southard's Ford I have the honor to state the following:

Our instructions designated some point of the river about 30 miles above the mouth as the starting point, and from the best information obtainable we judged this ford to be about at the proper distance from the mouth. A reconnaissance was made from a point 5 miles above Southard's Ford.

Above this ford the river is of a totally different nature from below; above the shoals are rock, and the fall is, I should judge, more rapid than below.

It partakes in general above this point more nearly of the nature of a mountainous stream. Below Southard's Ford the bars are gravel almost exclusively.

From our examination I should estimate the cost of improvement above this point as greater than below. One very serious log-jam occurs in the river about a mile above Southard's Ford.

The lower limit of such timber as is near enough to the river to be available for rafting is about 6 miles above Southard's Ford, and of course the lumber interests are now interested still farther up the river.

Very respectfully, your obedient servant,

H. E. WATERMAN,
First Lieutenant of Engineers.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

* Omitted.

3	Moody's Mills Dam	2.9	10	0.2	5.00	53	50	[illegible]
4	.....	3.0	997	0.5	2.05	10	7	40
5	.....	4.3	600	0.6	0.70	4	6	.....
6	.....	5.0	1,613	1.0	3.48	32	50	660
7	.....	5.4	1,015	1.5	2.24	40	71	170
8	.....	6.8	950	0.5	1.94	42	55	420
9	.....	7.0	600	1.0	0.36	2	.....	.....
10	.....	7.4	512	2.0	1.75	17	15	100
11	Thompson's Ford.	8.2	200	1.5	0.93	2	26	.....
12	.....	9.1	980	0.5	2.21	24	17	50
13	.....	9.7	565	0.5	0.36	5	.....	.....
14	Fish-trap	10.1	50	0.5	1.52	.....	.....	250
15	.....	10.7	700	1.0	1.65	8	14	350
16	.....	13.0	440	1.0	1.90	3	25	800
17	.....	14.0	6,000	1.0	5.07	68	97	610
18	Ford.....	15.5	600	1.0	0.89	.....	41	510
19	Mouth of Buzzard Roost Creek.	16.0	616	1.5	0.97	1	14	.....
20	Memphis and Charleston R. R. Bridge.	16.8	222	0.8	0.25	23	12	800
21	The Three Chutes.	18.0	7,172	1.0	4.59	97	107	1,240
22	.....	19.9	1,976	1.0	2.30	44	35	720
23	.....	21.5	2,635	2.0	3.61	25	53	2,920
24	Fish-trap	22.5	50	0.5	1.80	41	35	.....
25	.....	22.8	1,300	0.1	1.38	4	43	160
26	.....	24.0	350	3.0	0.32	20	25	.....
27	.....	24.6	950	3.0	0.72	11	21	90
28	Fish-trap	25.1	10	0.2	1.00	63	32	.....
29	.....	25.4	1,200	1.0	1.93	65	23	1,400
30	.....	26.2	410	2.0	0.50	53	42	.....
31	Fish-trap	27.0	30	0.5	2.05	.....	.....	.....
32	.....	27.6	205	3.0	0.66	32	32	300
33	.....	28.0	225	2.0	0.63	39	9	.....
34	.....	28.4	307	1.0	1.20	12	10	.....
35	.....	28.6	3,000	2.0	1.23	11	21	.....
36	.....	29.3	800	3.0	0.85	2	44	.....

APPENDIX B B.

IMPROVEMENT OF THE OHIO, MONONGAHELA, AND ALLEGHENY RIVERS · OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER; LOCK AND DAM NO. 9, MONONGAHELA RIVER, AND THE LOCKS AND DAMS ON THE MUSKINGUM RIVER; CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND OF LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

REPORT OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating and care of Davis Island Dam, Ohio River.
3. Monongahela River, West Virginia and Pennsylvania.
4. Operating and care of lock and dam No. 9, Monongahela River.
5. Allegheny River, Pennsylvania.
6. Dam at Herr's Island, Allegheny River.
7. Ice-harbor at mouth of Muskingum River, Ohio.
8. Operating and care of the locks and dams on the Muskingum River, Ohio.

EXAMINATIONS AND SURVEYS.

9. Ohio River, near the city of Evansville, Indiana, to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.
10. Big Hockhocking River, Ohio, from its mouth to Coolville.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 1, 1888.

SIR: I have the honor to submit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1888.

First Lieuts. Lansing H. Beach and Cassius E. Gillette, Corps of Engineers, have been on duty under direction of this office throughout the fiscal year.

On April 13, 1888, I transferred to Capt. D. W. Lockwood, Corps of Engineers, the works of improvement on the Big Sandy, Little Kanawha, Guyandotte, and Buckhannon rivers, which had been under my temporary charge since May 6, 1887.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF *OF ENGINEERS, U. S. A.*

sections were partly repaired, and the empty spac
of timbers in the lower slope were filled up solid,
placed. The work was done under the direction of l
assistant engineer, in charge of the dredging fleet,
in the neighborhood at the time.

Dike at middle of Grand Chain, 946 *miles below Pitt*
third or middle dike at the Grand Chain, and it is
under contract with I. V. Hoag, jr., dated Decembe

During the year the substructure of the dike wa
to a total length of 1,874 feet, and the superstructu
feet to a total length of 1,806 feet. The ultimate l
3,008 feet. At the request of the contractor the con
to December 1, 1888.

The lower dike at the Grand Chain ought to be e
wannee Rocks, a distance of 900 feet. It may also
tend the upper dike to the Richmond Rocks, a dista
is advisable, however, to postpone this extension u
is completed, as it is probable that the latter dike w
ing tendency of the current to cut around the upper
the extension unnecessary.

Removing rocks at Grand Chain.—Work was carr
tract with the Crescent City Wrecking Company,
1886. During the last fiscal year 10,573.9 tons of r
making, with the work done in the previous fiscal y
tons removed in 1887. The wrecking plant worke
Rocks at the head of the Grand Chain, on the Jac
of the Upper Dike, and on the Arkansas Rocks bet
quantity of rock removed at each place was as follo

Grenadier Rocks	
Arkansas Rocks	
Jackson Rocks	
Total	

The dredging was delayed by a rise in the river until the 16th day of June; from that date until the 30th of June, 897 tons of rock were removed from the Jackson Rocks. I discovered that these rocks were mostly covered with sand from the high waters of the previous winter and spring, and that the current created by the dike at this point, as the river falls, had not time to scour out the sand from over the rocks. I therefore decided to remove the plant to the Grenadier Rocks, and so reported to you at the time.

On the 5th of July the plant was removed to the Grenadier Rocks, which were found to be composed of very hard gray and blue limestone, standing up boldly out of the bed of the river in groups near the channel; in fact, so near the channel that the steamers had to make a detour in their course to avoid them.

Work was carried on at the Grenadier Rocks until the 24th of August, resulting in the removal of 3,932 tons of rock, when, on receipt of your letter of the 17th, the plant was removed to the Arkansas Rocks, as per order contained therein. At the Arkansas Rocks the work progressed from the 26th of August until the 17th of September, and 1,493 tons of rock were removed, when the plant was shifted to the Jackson Rocks; here the work had progressed scarcely one week when the pilot on the local packet reported striking rocks in the channel opposite the Grenadier Rocks. Upon investigation I found this to be the rock that had been worked on by the Hill Wrecking Company in 1881; the remaining portion of the rock had only 2 feet of water over it at low water. I therefore removed the plant to that point on the 23d of September, and reported the same to you, and you approved the change in your letter of September 26. The work was continued at the Grenadier Rocks until the 8th of October, by which time 669 tons (additional) of rock had been removed.

On the 8th of October the plant was again removed to the Jackson Rocks, and operations were continued at that point until running ice compelled work to close for the season on the 30th of December. On returning to the Jackson Rocks I found the sand all washed away by the strong current formed by the dike. During this second attack on the Jackson Rocks 4,480 tons of rock were removed.

The total quantities of rock removed by the Crescent City Wrecking Company during the season are as follows:

	Tons.
Grenadier Rocks	4,601
Arkansas Rocks	1,493
Jackson Rocks	5,378
Total	11,472

To break up this quantity of rock, the contractors expended 20,100 pounds of No. 1-XX (75 per cent. nitro-glycerine) of Hercules powder, and 9,800 platinum fuzes, being at the rate of 1¾ pounds of explosive per ton of rock; the cost per ton for explosives and fuzes was about 63 cents.

PLANT.

The contractors' plant consisted of one dredge-boat, with necessary quarters for all the men; one diving flat, 12 by 35 feet, with storage-room for diving outfit; one small towing steamer, and two decked flats or scows, 18 by 95 feet; the latter were used for transporting the rock to a safe place of deposit.

The dredge was provided with one Hayward's grappling-bucket, having four points or blades with a grasp of 7 feet; when closed it assumes the form of a hemisphere, and holds about 2 cubic yards of material.

The bucket was suspended from the end of a boom 45 feet long by two chains running back to two friction-drums, set 12 feet apart; one man operating these drums opens, closes, hoists, lowers, and swings the bucket to any desired position, making about 100 dips with the bucket per hour, and at times lifting out rock weighing over 3 tons.

MODE OF OPERATING.

The operations were carried on as follows: The blasting was done by a submarine diver placing the dynamite, or Hercules powder, either on the surface of the rock or alongside, or in a crevice as near the bed of the river as possible. After the charge was placed and the diver had come out, the diving-boat was hauled about 30 yards up stream, and the blast was exploded by a magneto-electric battery. The charges consisted of from 2 to 30 pounds of Hercules powder, made up by tying together the half-pound paraffined paper cartridges, with one platinum fuze in the charge and with no other protection from the water than the paraffined paper in which the Hercules powder is put up by the manufacturer. As the weather turned cold, and the Hercules powder was frozen, it was found necessary to use two platinum fuzes, placed close together, and to pass the *electric circuit through* both, making a petard strong

Landing, which is 4 miles above the head of Grand Chain, sh
on these rocks that the United States dredge-boat *Oswego* wa

4. The remainder of the Grenadier Rocks and Arkansas R
tending out to the channel, and should be removed.

5. The rocks opposite the dike being built at Grand Chai
come outside of the end of the dike, and, being near the chan

6. A reef of rocks extending out to the channel from the I
below Grand Chain Landing should be removed. It was
steamer *W. F. Nesbit* was damaged last November.

7. The extension of the upper dike about 700 feet to the
Rocks, and the extension of the lower dike about 900 feet
As the current draws around the end of these dikes and ov
them, it is necessary that these extensions should be made.

As a large portion of the material to be removed will like
gravel, I would recommend that a plant be chartered by th
be made in the specifications for classifying the material.

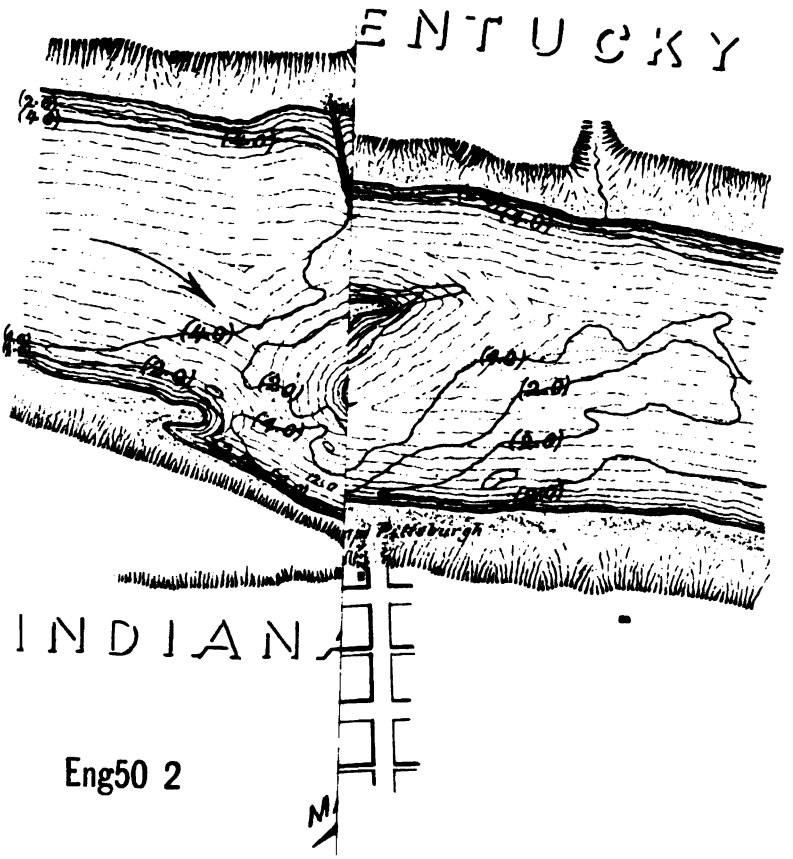
Additional work needed.—It will be observed tha
moving rocks and cemented gravel is needed in thi
located as follows:

At Grand Chain the remainder of the Grenadier
should be removed, as the channel at the head of
the Illinois shore, and therefore close to the rocks
250 tons of the Jackson Rocks, lying outside of
should be removed to give a clear channel betw
Kentucky shore. There are also some dangerous r
the line of the middle dike, now building at Grand
a rock reef, projecting well out into the river, abc
landing; both should be removed. It will also in
take out the remains of the "stone-boat" and of t
mond, although not in the channel.

At Little Chain, 8 miles above Grand Chain, th
and some cemented gravel in the middle of the ri
taken out.

The Hilderman Rocks, about 4 miles above the
Chain, are also much in the way, and one of the
was injured on them in 1884.

The Heady Rocks on the Illinois shore, about 2½ r
of Grand Chain, are sometimes troublesome, but



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The dredges spent the winter of 1886–'87 in the r
the mouth of the Muskingum, and in the latter part
towed up to Pittsburgh for the customary spring r
in that end of the river. Repairs were completed
and, under tow of the chartered steam-boat *J. J*
Stephen D. Davis, the fleet started on its season's

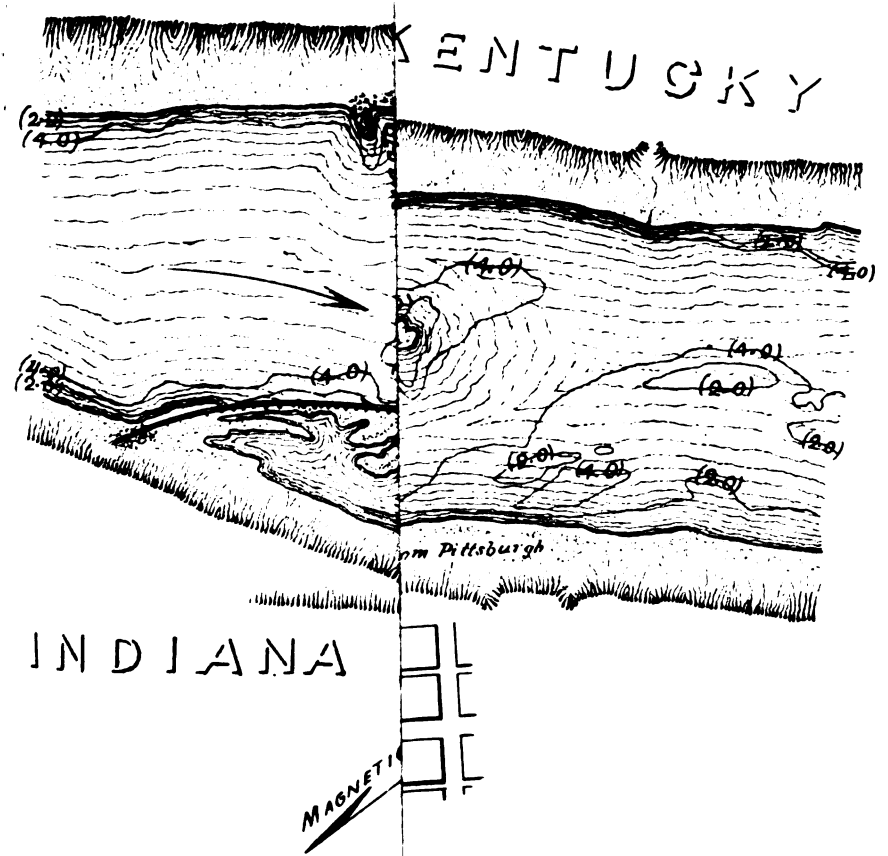
Davis Island Dam, 5 miles below Pittsburgh.—Th
ployed here in pulling out part of the old coffer-da
in deepening the channel of approach to the lock
piles were pulled, and 680 cubic yards of shale we
scantiness of the water, and the necessity for co
river before it should fall too low for travel, prevei
the riprap around the piling.

On the evening of June 18 the dredges starte
river being so low that it was not safe to stop at any
They got aground at Beaver Shoals and at Raccoon
the boats was injured on a natural-gas pipe that cro
latter place.

On June 20, the dredges arrived at the Steubenvil
six hours in removing two wrecked barges belo
arrived at Wheeling on the 21st, having lost one ho
the foot of Twin Islands.

Wheeling Creek Bar, 91 miles below Pittsburgh.—V
this bar on the 21st of June, and was continued unti
low stage of the river made it necessary to suspend
down the river. Two through cuts were made, ar
widened 65 feet. This bar was dredged off in 1882, b
of refuse brought out by the creek is constantly
cavation made June 21 to June 27, 6,607.5 cubi
weighing 3¾ tons, and one snag weighing three-fo
dug out of this bar.

Three Brothers Islands and Rowland's Race, 157–1
burgh.—The dredges arrived here on the 29th of J


KENTUCKY
(4.0)
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Pittsburgh
INDIANA
MAGNETI

Eng50 2

The following is a summary of the work done in this piece of river:

Place.	Excavation.	Rock.		Logs.		Wrecks removed.
		No.	Weight.	No.	Weight.	
	Cubic yards.		*Tons.*		*Tons.*	
Bar at head of Middle Brother	96,839	1	6.2			1
Shore-bar below Newell's Run	7,904			49	59.8	
Bar near foot of Middle Brother	18,687	1	2.3			
Shore-bar at Rowland's Race	7,942			1	0.7	
Gravel lump to left of Rowland's Race	9,148					
Total	140,520	2	8.5	50	60.5	1

On the 19th of November a small rise came that enabled the dredging fleet to pass down the river, and, on the 21st, the fleet entered the Muskingum River, where the dredges were employed until June, 1888. The record of this work will be found in the report on that river.

Dredges in commission, 1887.

Time at work:	Days.
Dredging gravel	112
Dredging shale, loose rocks, etc	8
Removing wrecks, logs, rocks, etc	3
	123

Time lost:	Days.
Traveling	4½
Accidents	7½
Sundays	23
At work on Muskingum River	40
	75
Total number of days	198
Total in commission in Ohio River	158

Work.

Gravel excavated per day of work, cubic yards	1,221.3
Gravel excavated during the season, cubic yards	139,224.2
Shale, loose rocks, etc., excavated per day of work, cubic yards	953.8
Shale, loose rocks, etc., excavated during the season, cubic yards	8,585
Total excavation during the season, cubic yards	147,808.2
Large rocks removed (number, 4), tons	12.25
Logs and snags removed (number, 51), tons	60.25
Number of wrecks removed	3
Number of piles removed	9

Cost.

Equipment:	
Per day in commission	$3.69
Per day at work	4.76
For the season	584.07
Towing:	
Per day in commission	34.62
Per day of work	44.47
For the season	5,470.00
Repairs:	
Per day in commission	1.31
Per day of work	1.68
Repairs—Continued:	
For the season	206.93
Salaries:	
Per day in commission	$34.02
Per day of work	43.71
For the season	5,375.88
Total:	
Per day in commission	73.64
Per day of work	94.62
For the season	11,636.88

Dredges out of commission, 1887.

Time:	Days.
In ordinary	90
Annual repairs	77
Total	167

Cost:	
Salaries in ordinary	$1,116.80
Towing, etc	450.00
Total in ordinary	1,566.80
Salaries during annual repairs	$3,374.73
Annual repairs	2,661.64
Total cost of repairs	6,036.37
Total out of commission	7,603.17
Total per day out of commission	45.47
Total per day in ordinary	17.41

Cost of work, including all expenditures, in 1887.

Dredging gravel	$17,284.77
Dredging shale, loose rocks, etc	1,407.81
Removing wrecks, snags, logs, etc	547.47
Total expenditure	19,240.05

Cost per unit.

Per cubic yard of gravel excavated	$0.12
Per cubic yard of shale, loose rock, etc., excavted	.16
Per day in commission	121.77
Per day of work	156.42

Statement of operations of dredges.

Date.	Miles below Pittsburgh.	Place.	Kind of work.	Days of work.	Excavation.				Rocks and logs.		No. of wrecks removed.	Expenditures.			Total for 1887.
					Gravel, etc.	Shale, loose rocks, etc.	Per day of work.	Cost per cubic yard.	No.	Weight.		Dredging gravel, etc.	Dredging shale, loose rocks, etc.	Rocks, logs, and wrecks.	
1887.					*Cu. yds.*	*Cu. yds.*	*Cu. yds.*			*Tons.*					
June	5½	Davis Island Dam	Dredging shale, etc.	1½		680	453.3	$0.305					$234.66		$234.64
Do	5½	do	Pulling piles, etc.	½					9					$78.21	78.21
Do	67½	Steubenville (Ohio), Bridge.	Wrecking	½							2			78.21	78.21
Do	90	Wheeling Creek Bar.	Dredging gravel	6	6,607.5		1,101.2	.112				$938.54			938.54
Do	90	do	Rocks	½					8	4.5				39.10	39.10
June and July	158½	Rowland's Race, shore-bar.	Gravel	7	7,942.4		1,134.6	.138				1,094.96			1,094.96
Do	158¾	Rowland's Race, island-bar.	do	7	9,147.6		1,306.8	.120				1,094.96			1,094.96
	158¾	Rowland's Race	Logs and rocks	½					2	6.9				39.10	39.10
July, August, September, October.	157½	Three Brothers, head Middle Island.	Gravel	74½	96,839.4			.120				11,653.54			11,653.54
October	157½	do	Wrecking	½							1			78.21	78.21
October and November.	158	Three Brothers, bar below head Middle Island.	Gravel	16	18,687.3			.134				2,502.77			2,502.77
Do	157¾	Three Brothers, shore-bar below Newell's Run.	Loose rocks, etc.	7½				.148					1,173.17		1,173.17
November	158	Bar below head and below Newell's Run.	Logs and 1 rock	1½		7,904			50	62.1				234.64	234.64
Total				123	139,234.2	8,584			64	73.5	8	17,284.77	1,407.81	547.47	19,240.05

WORK OF SNAG-BOAT IN 1887.

The snag-boat *E. A. Woodruff* was put in order for the season's work, and left Cincinnati on June 17, running up the river as far as Wheeling, 90 miles below Pittsburgh, where she was compelled to turn back on account of low water. From Wheeling she worked down the river to Cairo, thence up the river to Buzzard's Roost, 14 miles above Cincinnati, and thence to the mouth of Kentucky River, where she went into winter quarters on November 13. The total distance traveled during the season, including minor trips made while on the above-mentioned routes, was 2,125½ miles.

During the season 1,225 snags, 127 large rocks, and 16½ cubic yards of riprap, 46 new wrecks, and the remains of 13 wrecks, previously reported, were removed.

Among the wrecks the most notable were those of the wharf-boat at Huntington, W. Va.; the steamer *Jerry Osborn*, near Catlettsburgh, Ky.; the steamer *Good Intent*, at Lewisport (Ky.) Landing; the ferry-boat, opposite Paducah, and the steamer *Charles Morgan*, from the harbor at upper end of Cincinnati.

Among the larger snags removed may be mentioned one at Tobinsport Landing, weighing 50 tons; 3 from the channel near Grissom's, weighing 80½ tons, 60 tons, and 110 tons, respectively; 3 from the channel at head of Diamond Island, weighing 63½ tons, 62 tons, and 164 tons respectively; 1 from the channel at head of Walker's Bar, weighing 54½ tons; 1 just below Bennet's Landing, weighing 54 tons; 1 at head of Sisters Island, weighing 50 tons; 1 at Hurricane Creek, weighing 122 tons; 2 near Raleigh, weighing 57½ tons each; 1 near Butler's Landing, weighing 116½ tons; and a root just below the old locks of the Louisville and Portland Canal, weighing 48 tons.

It is worthy of note that during the summer and autumn of 1887 the Ohio River was continuously at a very low stage for the longest period ever known since regular gauge-records have been kept. During all this period of extraordinary low water the *Woodruff* was continuously at work, and was the only large steam-boat in commission on the river. She frequently had to spar her way over bars, and it took her four days to get over the bar at French Island; but she kept steadily at her work until she reached Cincinnati in the latter part of October. As a consequence of this work during very low water the river got a thorough cleaning, and many old snags that are covered with sand at ordinary stages were discovered and pulled out. The work was not done without considerable damage to spars and rigging, but the hull was apparently uninjured. The captain of the snag-boat, W. H. Christian, deserves the highest praise for the skillful and efficient manner in which he performed his duty. The sight of this large boat steadily working her way up the river when nothing else was running, except small stern-wheelers, was a constant surprise to the riparian population, and even to river men themselves. This fact settles the question of the adaptedness of the *Woodruff* to her work, and it is mainly due to the reduced draught caused by the lengthening of the boat in 1885.

It was possible to have continued work above Cincinnati, but coal was at famine prices, and almost impossible to get at any price, and the occasion did not seem to call for unusual expenditures or risks.

HARBOR OF REFUGE NEAR CINCINNATI, OHIO.

The work in progress at the date of the last annual report was the completion of the third dike at Four Mile Bar, under contract with

	Upper dik on Ohio shore.
Brush.....cords..	48
Riprap stone.....cubic yards..	18, 22
Timber.....feet B. M..	*656, 85
Bolts and spikes.....pounds..	65, 93
Excavation.....cubic yards..	.....
Total cost.....	$33, 695. 8
Length in feet.....	2, 13
Cost per running foot.....	$15. 7

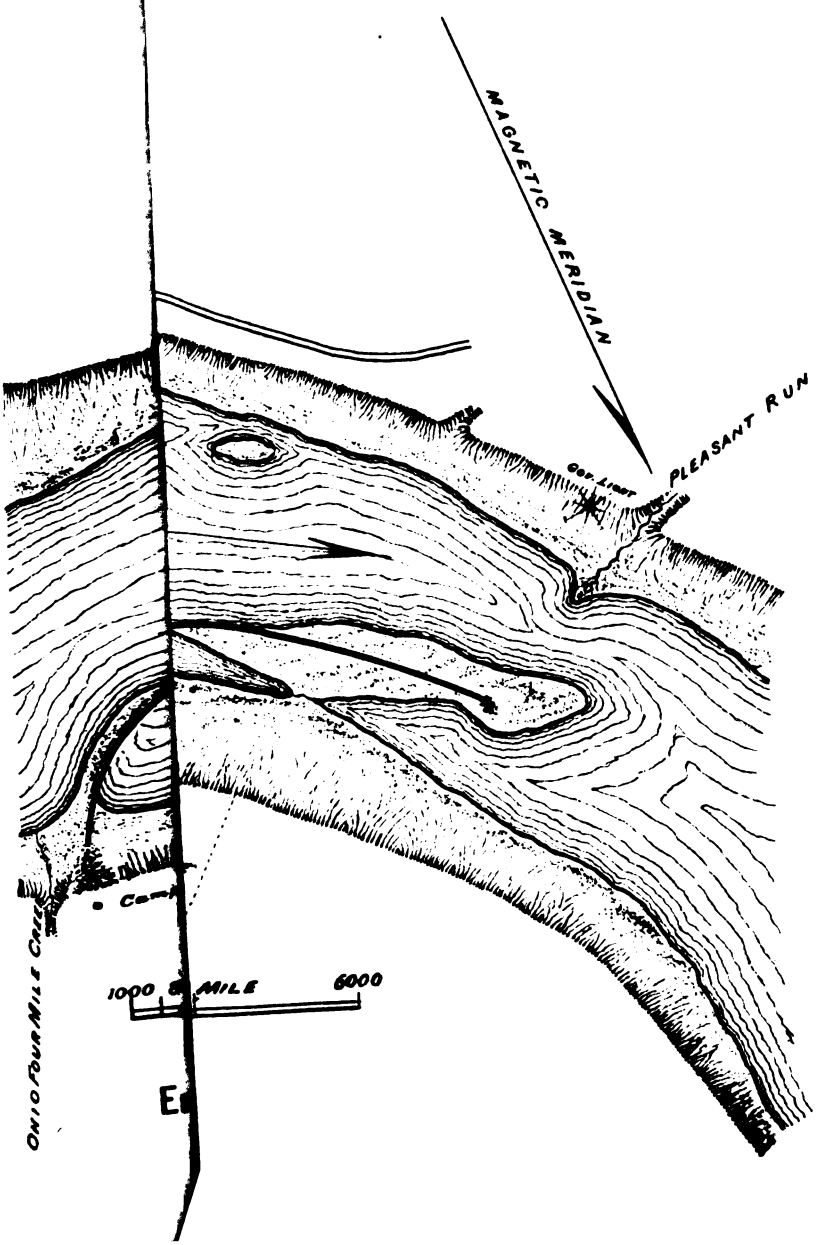
. The direct appropriations for the harbor of refu
the sum of $83,000, and the excess of cost above t
paid from appropriations for improving the Ohio Ri
ing been completed no further appropriation is req

The benefit of these dikes accrues to the gene
Ohio River, and to the local commerce of the city

The accompanying map shows the situation of t
relations to each other.

STAGES OF RIVER DURING 1887–

The past fiscal year has been noted for the long
water that has been known since continuous gauge-
at Cincinnati, in 1888. From July 7 to December
months, the gauge-reading at this city (except fo
than 6 feet, and from the 1st of July to the 1st of
six months, the gauge-reading never exceeded 8 f
dented low water had a very damaging effect on
pecially on the coal trade. No coal was shipped fr
June to the following January, and coal at Cincinn
reached famine prices. A considerable supply wa
to meet the urgent demand, but this kind of shipn
as coal could be brought down by river


MAGNETIC MERIDIAN
PLEASANT RUN
GOV. LIGHT
OHIO FOUR MILE CREEK
1000 MILE 6000

WATER-GAUGES.

Regular gauge-records of the oscillations of the Ohio River are kept for the use of this office at Pittsburgh, Davis Island Dam, Wheeling, Marietta, Cincinnati, Louisville, Evansville, Paducah, and Cairo. At Pittsburgh, Wheeling, Marietta, and Cincinnati, the records are taken from the gauges established by those cities, but the gauges at Louisville, Evansville, Paducah, and Cairo were established under the direction of this office, those at Louisville and Cairo being parts of the Mississippi water-gauge system.

There are also three Government gauges established for the benefit of passing boats, whose readings are not recorded. One is located at Belpre, Ohio, opposite Parkersburgh, and consists of a graduated iron bar resting on an inclined wooden sill, just even with the natural surface, which is supported on posts and is protected on both sides by paving. This gauge reads from low water to the 31-foot stage, and is designed to enable ascending boats to determine the head room under the Parkersburgh Bridge over the Ohio. Another is located at Campaign Point, opposite Addison, Ohio, and 3 miles above the Point Pleasant Bridge. This gauge consists of three stout vertical posts that give gauge-readings from the 20-foot to the 60-foot stage and is intended to enable descending boats to determine the head-room under the Point Pleasant Bridge over the Ohio. The third gauge is placed in the pump-house of the Newport (Ky.) Water-Works, 6 miles by river above the Newport and Cincinnati Railroad Bridge, and is intended to show, by direct observation, the head-room under this bridge. The gauge consists of a flexible band, 2 feet wide and 75 feet long, fastened at one end to a cylindrical float of sheet-iron, and wound up at the other end on a counter-weighted drum. The band is composed of black rubber cloth, backed by white muslin and re-enforced by brass-wire cloth. The gauge only shows the even-numbered figures, which are 12 inches high and are cut out of the rubber cloth, thus uncovering the white muslin backing and showing white figures on a black ground. At night a reflector is placed behind the gauge, and the illuminated figures are plainly visible through the muslin. This gauge was constructed in 1876, but the record was accidentally omitted from the annual report. Owing to its distance above the bridge, the oscillations of the river at the two locations do not agree, nor can any gauge be placed at the Newport Water-Works that will always give the correct head-room under the bridge; in view of this fact the gauge has been set so as to read as accurately as possible in high water, at which time it is most important to know the head-room under the bridge.

During the fiscal year the gauge at Belpre, Ohio, was repaired by filling up and paving around the upper section, where some scour had taken place, and the gauge at Evansville, Ind., was repaired by rebuilding the lower 80 feet of the gauge, the timbers of which had rotted. The paving on each side of the gauge had settled, leaving the iron bar projecting about 3 inches and exposed to injury by passing teams; this paving was raised and reset for the whole length of the gauge, 180 feet, so that the gauge-iron is now 2 inches below the paving.

SLOPE OF THE OHIO RIVER AT LOW WATER.

The slope of the Ohio Biver at low water, as determined by levels given in the reports of my predecessor, Mr. W. Milnor Roberts, dated April 21, 1870, is very irregular, and a summary of the local slopes will

be convenient for reference. It ought to be premised that the levels from Pittsburgh to Letart, a distance of 234 miles, were taken in 1837–'38; those from Letart to Clipper Mills, a distance of 37 miles, in 1844; and those from Clipper Mills to Cairo, 696 miles, in 1867–'68. The older levels are known to be somewhat inaccurate, but it is probable that the errors are not serious. For convenience in identifying the sections of the river the names and distance of the more important towns and cities have been added.

Table shewing the slope of the Ohio River from Pittsburgh to Cairo.

Miles below Pittsburgh.	Locality.	Miles below Pittsburgh.		Per mile.	Miles below Pittsburgh.		Per mile.
				Inches.			*Inches.*
		0 to	20	17.0			
25	Rochester	20	40	7.7			
		40	60	7.8	0 to	100	10.4
67	Steubenville	60	80	8.7			
90	Wheeling	80	100	10.8			
		100	120	9.3			
		120	140	6.7			
		140	160	7.3	100	200	7.[illegible]
171	Marietta	160	180	6.5			
183	Parkersburgh	180	200	7.1			
		200	220	6.3			
		220	240	9.4			
249	Pomeroy	240	260	7.3	200	300	6.[illegible]
267	Gallipolis	260	280	4.7			
		280	300	5.5			
306	Huntington	300	320	7.3			
325	Ironton	320	340	7.6			
353	Portsmouth	340	360	5.5	300	400	5.8
		360	380	4.1			
		380	400	4.4			
405	Maysville	400	420	3.2			
		420	440	3.3			
		440	460	4.0	400	500	3.5
466	Cincinnati	460	480	2.5			
493	Aurora	480	500	4.4			
502	Rising Sun	500	520	5.5			
		520	540	4.7			
553	Madison	540	560	2.9	500	598	3.2
		560	580	1.4			
598	Louisville	580	598	1.8			
		601	620	4.4			
639	Brandenburgh	620	640	3.5			
658	Leavenworth	640	660	4.2	601	700	3.8
		660	680	1.4			
		680	700	3.6			
		700	720	1.9			
740	Rockport	720	740	4.0			
749	Owensborough	740	760	3.8	700	800	3.1
		760	780	3.3			
783	Evansville	780	800	2.6			
818	Mount Vernon	800	820	4.0			
		820	840	2.3			
847	Shawneetown	840	860	4.2	800	900	3.2
860	Caseyville	860	880	3.8			
		880	900	1.8			
		900	920	2.2			
920	Paducah	920	940	1.6	900	967	1.5
965	Cairo	940	960	3.1			

The average slope from Pittsburgh to the head of the Falls at Louisville is 6.282 inches per mile, and from the foot of the Falls to the mouth of the river is 3.04 inches per mile. The descent at the Falls is 27 feet in about 3 miles.

NAVIGABILITY OF OHIO RIVER.

As the statement was once made that the Ohio River was frozen up for half the year and dry for the other half, and as this statement is

still quoted by those who are opposed to the improvement of the river, I have thought it worth while to examine the records, to see what are the actual facts in the case.

The minimum navigation for coal fleets may be taken as 6 feet on the shoalest bars, and the minimum navigation for steam-boats as 3 feet. The question of the readings on different gauges that correspond to these depths in the river can only be decided by the experience of navigators, as the bed of the river is more or less changeable, and the readings of the gauges do not necessarily show the depths in the river.

Pittsburgh gauge.—The 3-foot and 6-foot readings on this gauge show with considerable accuracy the corresponding depths for navigation. A careful study of the records during a period of twenty-four years, made in 1879 by Lieut. (now Capt.) F. A. Mahan, Corps of Engineers, shows the following average stages of water.

	Days.
Under 3 feet	81
Over 3 feet	284
Over 6 feet	156

In other words, there is steam-boat navigation at the upper end of the Ohio River for an average of 9½ months in the year, and coal-barge navigation for an average of 5 months in the year.

Cincinnati gauge.—As the bed of the Ohio River near Cincinnati is largely composed of shifting sand, and as the zero of the gauge is below low water, there is no exact agreement between gauge readings and depths for navigation, but as a rule we may take the 4-foot gauge reading as corresponding to at least 3 feet in the channel, and the 7-foot reading as corresponding to at least 6 feet in the channel.

A comparison of 30 years' records shows the following average depths for navigation:

	Days.
Under 3 feet	20
Over 3 feet	345
Over 6 feet	296

Evansville gauge.—At this gauge we only have a continuous record for fourteen years. The zero of the gauge is at low-water mark, and a guage reading of 2 feet shows at least 3 feet in the channel, while a gauge reading of 6 feet corresponds to not less than the same depth in the river. On this basis we have the following average depths for navigation:

	Days.
Under 3 feet	23
Over 3 feet	342
Over 6 feet	277

It will be noted as an anomaly that there is better navigation at Cincinnati than at Evansville, 317 miles nearer the mouth of the river. This seems to be due to the fact that the river is much narrower at Cincinnati, and there is less traveling sand to choke up the channel.

Stoppages by ice.—To determine the average stoppages of navigation by ice, it was thought that the records of a central station like Cincinnati would give a fair average for the whole river. The following has therefore been compiled from the files of the Cincinnati Commercial Gazette and from the annual reports of the Cincinnati Chamber of Commerce.

Effects of ice on navigation at Cincinnati.

Winter of—	Navigation suspended by running ice.	River entirely closed.	River open and navigation resumed.	Duration of suspension.	Remarks.
				Days.	
1857–'58					No serious interruption.
1858–'59					Do.
1859–'60	January 2		January 10	8	
1860–'61					Do.
1861–'62					Do.
1862–'63					No serious interruption; river high.
1863–'64	January 4 February 19	January 17	January 25 February 23	25	
1864–'65	January 30		February 6	7	
1865–'66	February 15		February 20	5	
1866–'67	December 30		February 5	37	Occasional trips could be made.
1867–'68	January 19 January 31		January 23 February 15	19	Do.
1868–'69					No serious interruption.
1869–'70					No serious interruption; river high.
1870–'71	December 24		January 14	21	
1871–'72	December 19 December 28 January 9 January 27	December 21 December 29 January 10 January 30	December 24 December 31 January 12 February 20	35	
1872–'73	December 13	December 23	January 4	22	Heavy ice running until February 6.
1873–'74					No serious interruption.
1874–'75	January 12		January 30	18	
1875–'76					No serious interruption; river high.
1876–'77	December 9		January 18	40	Ice began moving out January 13.
1877–'78					Free of ice all winter.
1878–'79	December 25	January 3	January 15	21	Occasional trips could be made until January 3.
1879–'80					Free of ice all winter.
1880–'81	December 28	December 29	January 13	16	Ice began moving out January 8.
1881–'82	February 3 February 14		February 8 February 15	6	
1882–'83					No serious interruption.
1883–'84	January 7		January 31	24	Occasional trips could be made.
1884–'85	December 25 January 27 February 11 February 20		December 29 February 2 February 13 February 26	18	Do.
1885–'86	January 13 February 5		January 20 February 8	10	Occasional trips could be made down-stream.
1886–'87	January 4		January 14	10	Occasional trips could be made.
1887–'88	January 22	December 29	January 3 January 31	14	Do.
Total				356	
Average stoppage per year				11½	

In my annual report for last year will be found statements as to the effect of ice on navigation between Louisville and Cairo. (Report of Chief of Engineers, 1887, page 1795.)

HISTORICAL SKETCH OF THE IMPROVEMENT OF THE OHIO RIVER.

On the 27th of January, 1817, the general assembly of the State of Ohio by joint resolution requested the States of Pennsylvania, Virginia, Kentucky, and Indiana to unite with Ohio in appointing commissioners to examine the Ohio River, and submit a report of its condition and the amount of money required to improve its navigation. A special exami-

nation was to be made at the Falls of the Ohio at Louisville, in order to determine upon the best method of passing these falls, by canal or otherwise, and, in case a canal was decided upon, to select the side on which it should be built. At the same time the Senators and Representatives in Congress from Ohio were requested "to use their best endeavors, in the event of the creation of a fund for internal improvements, to procure a portion thereof for the above purpose."

These propositions from Ohio were accepted by Pennsylvania, Virginia, and Kentucky, and the four commissioners thus appointed made a report, which is dated November 2, 1819. They gave sketches of all the bars between Pittsburgh and Louisville, with the depth and fall at each bar, and a map and cross-section of the Falls at Louisville, with two routes for a lateral canal. They gave their preference to the route on the Kentucky side. They estimated the cost of a suitable canal at Louisville at $380,594, and recommended an appropriation of $10,000 by each of the four States for use on the river at large. No action was taken by the States on this report.

The first appropriation was made by Congress in 1820 for a survey from Louisville to Balize (the mouth of the Mississippi). This survey was made in 1821, by Captains Young and Poussin, of the Topographical Engineers, and Lieutenant Tuttle, of the Engineers. It gave a continuous outline plat of the Ohio River from Louisville to its mouth, and of the Mississippi River from Saint Louis to New Orleans.

The first appropriation by Congress for the improvement of the Ohio was one of $75,000, made in 1824, for the improvement of certain sandbars in the Ohio River, and for the removal of snags from the Ohio River, and from the Mississippi River from the mouth of the Missouri to New Orleans. The President was directed to take any two of the following bars in the Ohio River, viz, Flint Island, French Island, Henderson, Straight Island, Willow Island, and Lower Smithland, for experiment; and in case of success, he was authorized to undertake work on the others.

The first dike on the Ohio River was begun in 1825, at Henderson Bar, under the personal direction of Maj. S. H. Long, topographical engineer. The removal of the rocks at the Grand Chain was begun in 1830. Dikes were begun at Scuffletown and The Sisters in 1831, and at French and Cumberland islands in 1832.

No work, except the removal of snags, was done on the Ohio above Louisville until 1836, when the dams at Brown's Island were begun. The success of these works was such that a very large number of dams and dikes were subsequently built between Pittsburgh and Cincinnati, from this time until the general stoppage of work in 1845.

From 1827 to 1844, inclusive, there were annual appropriations for the improvement of the Ohio River, sometimes alone and sometimes in conjunction with the Mississippi, the Missouri, and the Arkansas.

In 1845 the policy of the Government changed, and except about $500 in 1847 and $150,000 in 1852 for the four great Western rivers, there were no further appropriations until 1866. Since the latter date an appropriation for the improvement of the Ohio River has been made in every year except 1869, 1877, 1883, 1885, and 1887.

The movable dam at Davis Island was first recommended in my annual report for 1874. The first appropriation for this work was contained in the river and harbor act of March 3, 1875. Owing to delays in getting cession of jurisdiction from the State of Pennsylvania over the land required for the work, actual construction was not begun until August 19, 1878. The lock and dam were finally completed and opened to commerce on *October 7, 1885.*

Dams and dikes of riprap and crib-work.

Miles below Pittsburgh.	Place.	Date.
2	Duck Chute	Dam built in 1873.
2½	Glass-house	Dam built in 1871 and 1872.
3	Chartiers Creek	Dam built in 1871, 1872, and 1873.
5	Davis Island	Dam partly built in 1844.
5½	Neville Island	Do.
8	Duff's	Small dike built in 1844.
9	Merriman	Dike built in 1885, 1886, and 1887.
11	Foot of Neville Island	Dam built in 1877.
11	White's	Dikes and cross-dam partly built in 1838–'39. Repaired in 1844 and 1867. Rebuilt in 1876, 1877, and 1878. Repaired in 1883.
12	The Trap	
19	Logstown	Dikes built in 1867 and 1868.
27	Beaver Shoals	Dike built in 1870.
50	Baker's Island	Dam partly built in 1844.
54	Black's Island	Dam partly built in 1844. Rebuilt in 1885, 1886, and 1887.
61	Brown's Island	Curved wing-dam built in 1836–'37. Dam at head built in 1837 and 1838. Rebuilt in 1881, 1882, and 1883. Repaired in 1884–'85.
70	Mingo Island	Dam built in 1844.
78	Beach Bottom Bar	Dam partly built in 1844.
		Dam partly built in 1844. Completed in 1867, 1869, 1871, and 1872.
84	Twin Islands	Dike at foot of Upper Twin built in 1871 and 1872.
89	Wheeling Island	Dam built in 1869, 1872, and 1873. New dam built in 1885–'86.
107	Captina Island	Dam built in 1844. Repaired in 1854, 1867, 1869. Rebuilt in 1885 and 1886.
112	Fish Creek Island	Dam partly built in 1844. Repaired in 1867, 1868, and 1869. Rebuilt in 1885–'86.
128	Fishing Creek Bar	Dam built in 1844.
133	Williamson's Island	Dam partly built in 1844 across left of channel, and small dam built at foot of island.
138	Well's Island	Dam partly built in 1844.
140	Mill Creek Island	Do.
141	Grand View Island	Do.
143	Grand View Shoals	Dike built in 1869.
146	Shift-tail Ripple	Do.
147	Petticoat Ripple	Dike partly built in 1844. Repaired in 1867.
157	Three Brothers Islands	Dam partly built in 1844 to head of second island. Rebuilt in 1885–'86. Repaired in 1887.
168	Marietta Island	Dam at head built in 1871, 1872, and 1873. Dike at foot of island built in 1844. Rebuilt in 1875.
174	Muskingum Island	Dam commenced in 1844. Repaired and finished in 1868.
180	Cole's Island	Dam partly built in 1844.
185	Blennerhassett's Island	Dam at head built in 1844. Repaired in 1867–'68. Dike at foot of tow-head and wing-dam built in 1867, 1868, and 1869.
193	Newberry Island	Dam partly built in 1844.
202	Belleville Island	Dam partly built in 1844. Dike to middle bar and dike at foot of same built in 1844. Repaired in 1869.
214	Buffington Island	Curved wing-dam in left channel built in 1844. Repaired in 1867 and 1873. Spur-dike built in 1868 and removed in 1873. Dam at head built in 1867, 1868, 1869, and 1873.
220	Sand Creek	Dike built in 1885, 1886, and 1887.
232	Letart's Island	Dam built in 1844.
237	Raccoon Island	Do.
312	Twelve Pole	Dike built in 1881, 1882, and 1883.
385	Brush Creek Island	Dam partly built in 1844.
453	Eight Mile	Dike built in 1885–'86.
457	Four Mile	Upper dike built in 1879 and 1880. Middle dike built in 1880–'81. Lower dike built in 1885, 1886, and 1887.
485	Nedoc	Dike built in 1870–'71.
501	Rising Sun	Dike built in 1870 and partly removed in 1884. New dike built on Indiana shore in 1885–'86.
525	Warsaw	Dike built in 1870.
581	Grassy Flats	Dike partly built in 1844.
601	Sand Island	Dam built in 1871.
603	Portland	Dike built in 1881, 1882, and 1883.
743	Puppy Creek	Do.
758	French Island	Dike at foot of island built in 1832. Kentucky dike rebuilt and island dike repaired in 1873, 1874, and 1875. Repaired in 1878–'79.
767	Scuffletown	Dikes built in 1832.
770	Three Mile Island	Dike built in 1833–'34.
783	Evansville	Dike built in 1873, 1874, 1875, 1876, 1878, and 1879.
796	Henderson Island	Dam across Kentucky Channel built in 1873, 1874, and 1875. Dike built in 1824–'25. Rebuilt in 1873, 1874, and 1875. Dam and dike repaired in 1879.
893	Sisters Islands	Dikes built in 1832.
907	Cumberland Island	Dam begun in 1832 and partly finished. Repaired in 1839 and 1854. Repaired and completed in 1872, 1873, and 1874. Removed in 1876–'77.
943 to 848	Grand Chain	Upper dike built in 1879–'80, 1881–'82, and 1883–'84. Lower dike built in 1880–'81 and 1882–'83. Middle dike begun in 1885.

The Louisville and Portland Canal was begun in 1825 and completed in December, 1830. As originally built it consisted of a canal 2 miles long and 64 feet wide, with a flight of three locks at the lower end, each lock having a length between hollow quoins of 198 feet and a width of 50 feet. In 1860 the work of widening the canal and of building larger locks was begun, and was finally completed in 1872. The enlarged canal is 86½ feet in width, and the two outlet locks are 351 feet in length between hollow quoins, and 80 feet wide. The old locks have been retained, but the three chambers have been reduced to two, making the lengths between hollow quoins 297 feet. Extensive operations are now in progress, having for their object the creation of a large harbor in the river near the present head of the canal, the removal of the upper half mile of canal, the widening of the second half mile, and the lengthening of the basin at the head of the new locks. After these improvements are made there will remain only a little more than a mile of canal in which boats can not pass each other under way.

Bridges over the Ohio River.

Name.	Kind.	Miles below Pittsburgh.	Length of approach on right bank.		Length of approach on left bank.		Length of main bridge.	Total length.		Clear width at low-water, measured on axis.
			Railroad.	Highway.	Railroad.	Highway.		Railroad.	Highway.	
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Ohio Connecting Railway.*	Railroad	2	1,214	.....	124	.....	3,132	4,470	.....	{400 / 500
Beaver	do	26	1,108.5	.....	31.5	.....	1,346	2,486	.....	426
Steubenville	do	67	0	.....	0	.....	1,895.4	1,895.4	.....	303
Wheeling†	Highway	90	.....	0	.....	0	980	.....	980	980
Bellaire	Railroad	94	1,702	.....	864	.....	1,435.5	4,001.5	.....	322
Parkersburgh	do	183	726	.....	1,994	.....	1,540	4,200	.....	{326½ / 326½
Point Pleasant	do	263	2,044	.....	1,515	.....	1,370	4,929	.....	400
Newport and Cincinnati.	Railroad and highway	466	1,972	405	585.3	296	1,646	4,203	2,347	400
Newport and Cincinnati.‡	Highway	466¼	.....	797.5	.....	311	1,532	.....	2,640.5	500
Covington and Cincinnati.‡	do	466¾	.....	0	.....	0	1,619	.....	1,619	1,005
Chesapeake and Ohio*	Railroad and highway.	467	1,748.7	963	1,533.3	941.5	1,530	4,812	3,434.5	524.3
Cincinnati Southern	Railroad with footway.	468½	2,223	.....	110	.....	1,489	3,822	.....	500
Ohio Falls	do	599	0	.....	0	.....	5,220	5,220	.....	{380 / 352½
Kentucky and Indiana.	Railroad with highway.	602	748	.....	4,029	.....	2,453	7,230	.....	{461 / 464
Henderson	Railroad	794½	480	.....	625	.....	2,519	3,624	.....	500
Cairo*	do	963	7,851	.....	8,000	.....	4,395	20,246	.....	{503 / 503

Bridge over the Ohio River—Continued.

Name.	Kind.	Clear width of draw-span at low water.	Channel-span above low water.	Channel-span above high water of 1832.	Maximum oscillation of river surface.		Maximum grade per mile.		Maximum curvature of track.	Maximum grade of track equated at 2.4 feet.
							Railroad.	Highway.		
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Year.*	*Feet.*	*Feet.*	*Degrees.*	*Per degree*
Ohio Connecting Railway.*	Railroad	.....	82½	51.33	33.17	1884	50.2	.....	11	76.6
Beaver	...do	.....	88.9	45.87	43.36	1884	13.2	.....	0	13.2
Steubenville	...do	.....	89.6	45.3	47.35	1884	0	.....	0	0
Wheeling†	Highway	.....	91.5	48	51.12	1884	.....	253	.....	.....
Bellaire	Railroad	.....	90	46.5	51.12	1884	52.8	.....	5	64.8
Parkersburgh	...do	.....	90	40.5	52.0	1884	52.8	.....	4½	63.2
Point Pleasant	...do	.....	91.4	38.6	60.44	1884	79.2	.....	5	79.2
Newport and Cincinnati.	Railroad and highway.	.....	98.1	36	69.14	1884	110	334	10¼	134.6
Newport and Cincinnati.‡	Highway	.....	102–105.3	40–43.3	69.14	1884	.....	251.4	.....	.....
Covington and Cincinnati.†	...do	.....	92–103	30–41	69.14	1884	.....	283	.....	.....
Chesapeake and Ohio*	Railroad and highway.	.....	105.3	43.3	69.14	1884	105.6	243	9	127.2
Cincinnati Southern	Railroad with footway.	160	102.4	40	60.14	1884	79.2	.....	3	86.4
Ohio Falls	...do	114	96.5	45.1	56.5	1884	79.2	.....	0	79.2
Kentucky and Indiana.§	Railroad and highway.	160	106.5	40	71.0	1884	64.4	.....	8½	84.8
Henderson	Railroad	.....	101.3	55	37.8	1884	74	.....	0	74
Cairo*	...do	.....	105.2	53 (1867)	53.83	1884	39.6	.....	4½	44.6

* Building. † Suspension. ‡ Not begun. § Cantilever.

Revised list of losses by collision with piers, etc., of Ohio River bridges. Compiled June 30, 1888.

BEAVER BRIDGE.

[Completed in 1878.]

Date.	Owner.	Vessel.	Losses.	Amount.
		Tow-boat.		
Jan. 14, 1878	Joseph Walton & Co.	Joseph Walton	Two barges and coal	$3,500
Jan. —, 1878	Thomas Fawcett & Sons	.....	Four coal-boats and coal	8,100
Aug. 3, 1878	W. H. Brown	.....	Barge and coal	2,000
Sept. 15, 1878	George Lysle & Sons	George Lysle	Two coal-barges and coal	3,271
Dec. 4, 1880	W. H. Brown	Alex. Swift	Three barges and coal	6,000
Dec. 7, 1880	Thomas Fawcett & Sons	W. C. McGaffey	Two barges and coal	3,500
Feb. 14, 1881	John A. Wood & Son	Ella	Flat-boat and coal	222
Jan. 15, 1882	...do	Tom Rees, No. 2	...do	550
Jan. 30, 1882	George T. Meller & Co	Raven	Two coal-boats and coal	4,715
Feb. 17, 1886	The Marmet Company	Lioness	Three coal-boats and coal	4,495
Jan. 10, 1888	J. C. Risher & Co	Smoky City	Coal-barge, fuel, flat, and coal.	3,000
Feb. 22, 1888	Blackburn Brothers	Ed. Roberts	Coal-barge and coal	1,000
		Passenger-boat.		
Feb. 24, 1888	.....	Scotia	Steamer damaged	2,500
	Total	.....	.....	42,853

Revised list of losses by collision with piers, etc., of Ohio River bridges, etc.—Continued.

STEUBENVILLE BRIDGE.

[Completed in 1863.]

		Tow-boat.		
Dec. —, 1862	Thomas Fawcett & Sons		Coal-boat and coal	3,748
May —, 1863	do		do	3,820
July 25, 1865	Horner, Wood & Co	Warrior	One barge and coal	3,350
May —, 1867	John F. Dravo		Two flat-boats and coal	5,000
May 9, 1867	William H. Brown	Mary Davage	Two barges and coal	5,600
Mar 12, 1868	Hays Coal Company	Diamond	do	4,500
Mar. 12, 1868	Stone & Co	Coal Valley	Three barges and coal	8,500
Mar. 12, 1868	J. N. & W. O'Neil & Co	Fred Wilson	One barge and coal	2,300
Apr. 22, 1869	Horner, Wood & Co	Ella	Two barges and coal	4,000
Apr. 22, 1869	do	do	One flat-boat and coal	2,500
Apr. 22, 1869	do	do	One fuel-boat	900
Apr. 2, 1869	William H. Brown	Sampson	Seven barges and coal	17,638
Apr. 2, 1869	do	do	Five fuel-boats	4,500
Apr. 5, 1869	Horner, Wood & Co	Simpson Horner	One flat-boat and coal	2,800
Apr. 15, 1875	John A. Wood & Son	B. D. Wood	do	400
Apr. 17, 1884	Gray's Iron Line		Barge Riverside	3,500
			Cost of raising of steel rails.	1,185
			Loss of lines, etc	250
Apr. 4, 1885	W. H. Brown Sons	Harry Brown	Coal-barge and coal	1,700
Apr. 20, 1886	do	J. S. Fisher	Coal-barge and coal	2,400
Apr. 20, 1887	Sneathen & Wilson	Onward	Five barges, one fuel-boat, and 69,500 bushels coal.	7,877
	Total			86,468

BELLAIRE BRIDGE.

(Completed in 1871.)

—, 1867	Thomas Fawcett & Sons		Barge and cargo of fire-brick.	2,400
Jan. 5, 1869	B. M. Laughlin	Boaz	One brick-boat and brick	2,500
Jan. 5, 1869	William H. Brown	Resolute	One flat-boat and coal	2,000
Jan. 5, 1869	Dippold & Co	Reindeer	One barge and coal	2,000
Jan. 14, 1870	J. D. Johnson & Co	Star	Steamer, total loss	28,000
Jan. 14, 1870	do	do	Six barges and coal	12,500
Jan. 14, 1870	do	do	One coal-boat and coal (two lives lost).	2,000
—, 1871	M. McDonald	Lioness No. 2	One barge and coal	2,000
Jan. 1, 1871	J. V. McDonald & Co	Lioness	Two barges and coal	6,000
Jan. 2, 1871	N. J. Bigley	Picket	One coal-boat and coal	3,000
Jan. 3, 1871	Marsh McDonald	Fearless	do	3,000
Jan. 3, 1871	W. H. Brown	Baltic	One barge and coal	2,000
Jan. 3, 1871	do	Alice Brown	Model barge	5,000
Jan. 3, 1871	do	Jim Brown	Two barges and one flat	3,000
Jan. 14, 1872	Joseph Walton & Co	Gipsey	One barge	1,200
Jan. 23, 1873	Wheeling and Parkersburgh Transportation Company.	Express No. 2	Steamer, damages	1,000
Jan. 23, 1874	James Lynn & Son	Panther	Coal-boat and coal	3,120
Jan. 23, 1874	Miller, Nickel & Co	do	do	950
Jan. 23, 1874	do	do	Coal-barge damaged	200
Jan. 14, 1874	do	do	One coal-boat, one barge, and coal.	4,475
Jan. 14, 1874	Lynn & Wood		Coal-boat damaged	500
Jan. 15, 1874	Wheeling Tow-boat and Barge Company.	Ed. Hobbs	Barge and cargo of ore	5,500
Jan. 6, 1877	W. H. Brown	Chas. Brown	Barge and coal	2,000
—, 1877	R. C. Gray		Barge Giant, total loss	8,000
			Loss on cargo of same	12,000
—, 1880	Thomas Fawcett & Sons		Barge and coal	2,400
Jan. 3, 1885	J. C. Risher & Co	Smoky City	Coal-boat and coal	2,500
Jan. 23, 1888	Jos. Walton & Co	Jos. Nixon	Fuel-barge and flat	1,300
	Total			120,545

Revised list of losses by collision with piers, etc., of Ohio River bridges, etc.—Continued.

PARKERSBURGH BRIDGE.

[Completed in 1871.]

Mar. 12, 1868	Dippold & Co	Tigress	One barge and coal	2,000
Sept. 4, 1869	J. Gilmore	Gilmore	do	2,000
Dec. 5, 1869	Hays Coal Company	Diamond	Two barges and coal	4,000
Dec. —, 1869	William Robbins	Gilmore	One barge and coal	2,000
Dec. 25, 1869	J. Gilmore	do	do	2,000
Jan. 30, 1870	William H. Brown	Greyhound	do	2,000
Jan. 30, 1871	do		do	2,000
Jan. 30, 1872	do		do	2,000
Jan. —, 1873	Unknown	Kate Waters	do	2,000
1872 or 1873	Miller, Nickel & Co	Collin	Coal-boat and coal	800
Mar. 19, 1879	Jacob Heatherington	Jacob Heatherington.	One barge and coal	1,600
Nov. 19, 1879	M. McDonald	Veteran No. 2	Coal-tow damaged	700
Dec. 14, 1882	W. H. Brown Sons	Lioness	One coal-flat and coal	700
May 13, 1884	J. C. Risher & Co	Tom Lysle	One barge and coal	2,000
Apr. 14, 1887	John A. Wood & Son	S. L. Wood	Two barges, two coal-boats, and three fuel-flats, with 54,400 bushels coal.	4,147
June 13, 1887	W. H. Brown Sons	Sam Brown	One coal-flat and coal	675
		Passenger-boats.		
Jan. —, 1870	Booth, Battelle & Co	Rebecca	Steamer total loss (four lives lost).	30,000
Feb. 6, 1870	Booth, Battelle & Co	Major Anderson	Steamer damaged	1,400
Nov. 24, ——	W. Guss & Co	Ellena May	Steamer damaged (pilot injured).	500
	Total			62,522

POINT PLEASANT BRIDGE.

[Completed in 1884.]

		Tow-boat.		
Feb. 13, 1883	W. H. Brown Sons	Alarm	Three coal-boats and coal	6,200
Apr. 25, 1887	John A. Wood & Son	S. L. Wood	Tow-boat damaged	800
Jan. 11, 1888	Jos. Walton & Co	J. C. Fisher	Four fuel-flats	1,600
	Total			9,600

NEWPORT AND CINCINNATI RAILROAD BRIDGE.

[Completed in 1872.]

Dec. —, 1870	Mulvehill & Co	Tom Rees No. 2	One barge and coal	2,000
Dec. —, 1870	Peytona Coal Company	Pierpont	do	2,000
Dec. 2, 1871	Walter B. Brooks		Barge and cargo of salt	3,000
Dec. —, 1872	J. P. Hale	Lookout	Two salt-barges and salt	6,000
Mar. —, 1878	Means, Kyle & Co	Cobb Cecil	Barge lost	925
Jan. 8, 1880	Jos. Walton & Co	W. C. McGuffey	Three coal-barges and coal	6,700
Feb. —, 1880	W. H. Brown	Lioness	One barge and coal	2,000
Apr. 6, 1885	Jos. Walton & Co	Bengal Tiger	Two coal-barges, one fuel-barge, and coal.	3,904
Feb. 18, 1886	do	Jno. F. Walton	Resulting damage to fleet of H. Brown Sons, paid by Jos. Walton & Co.	634
			One coal-boat and two fuel-barges.	2,944
		Passenger-boat.		
Feb. —, 1880	Big Sandy Packet Company	Bostona	Steamer damaged	7,000
June 3, 1882	John N. Hart	R. R. Springer	do	5,000
	Total			42,107

Revised list of losses by collision with piers, etc., of Ohio River bridges, etc.—Continued.

CINCINNATI SOUTHERN RAILWAY BRIDGE.

[Completed in 1877.]

Nov. —, 1877	Sheridan Mining Company		One barge	$400
Nov. —, 1887	Syracuse Coal Company		Two floats and coal	1,612
Nov. —, 1887	Sehon Coal Company		Two barges and coal	3,000
Nov. —, 1887	U. Shinkle		Damage to floats	300
		Passenger-boat.		
Feb. 15, 1880	United States Mail Line Company.	United States	Steamer damaged	4,500
	Total			9,812

OHIO FALLS BRIDGE.

[Completed in 1871.]

		Tow-boat.		
Dec. 13, 1869	J. S. McDonald	A. J. Baker	One coal-boat and coal	$3,000
Dec. 25, 1869	William H. Brown	Mary Alice	Four coal-boats and coal	15,892
Dec. 25, 1869	do	do	One barge and coal	1,812
Mar. 15, 1869	J. S. McDonald	Hornet	do	2,000
May —, 1870	Stuart & Graves	Bengal Tiger	do	2,000
Feb. 25, 1871	A. J. Hutchinson	Newcomb	do	2,000
Apr. 9, 1872	R. C. Gray	Iron Mountain	Barge *Eugenie* total loss	10,000
			Loss on cargo	3,500
			Barge *McConnell* and coke	6,547
			Coal barge and coal	2,500
Mar. 26, 1882	John A. Wood	Jim Wood	Coal-boat and coal	2,357
	W. H. Brown & Co	Mary Alice	Seven barges and coal	14,000
Feb. 5, 1883	W. H. Brown Sons	Sam Brown	Model barge and coal	4,800
Mar. 30, 1886	do	Iron Age	Coal-boat and coal	2,160
May 27, 1886	do	Harry Brown	Coal-boat and coal	2,640
— —, 1887	Louisville and Evansville Mail Line Company.	Mattie Hays	Damage to empty barge	150
		Passenger-boat.		
Feb. —, 1880	William Kirker	Eldorado	Loss on hull and cargo	4,992
	Total			80,350

KENTUCKY AND INDIANA BRIDGE.

[Completed in 1886.]

		Tow-boat.		
Feb. 3, 1887	Jos. Walton & Co	Jno. F. Walton	Coal-boat and coal	$1,950
April 25, 1887	do	Sam Clark	do	2,067
		Passenger-boat.		
Mar. —, 1887	Louisville and Evansville Mail Line Company.	Rainbow	Damage to boat	250
	Tota			4,267

HENDERSON BRIDGE.

[Completed in 1885.

		Tow-boat.		
June 22, 1885	W. H. Brown Sons	Harry Brown	Seven coal-boats and coal	$18,480

OPERATION OF DRAWS IN HIGH BRIDGES.

Three of the bridges over the Ohio River, the Cincinnati Southern, Ohio Falls, and Kentucky and Indiana, have draws in addition to being high bridges. The draw of the Ohio Falls Bridge was built for the Louisville and Portland Canal, but its river arm has occasionally been utilized in high water, though located in a part of the bridge that is reached with difficulty.

The question of the necessity of draws in bridges that are 40 feet above high water is one on which there is some difference of opinion, and it is, therefore, advisable to ascertain the facts as to the use made of such draws. If they are not useful it is unjust to compel their construction by companies bridging the Ohio River. The latest Ohio River bridge law permits the construction of bridges without draws, provided they are 53 feet above high water, but at many localities it is impracticable to build bridges to such a height, and bridge companies must accept the alternate plan of 40 feet height with a draw.

In preparing the following table I have omitted the Ohio Falls Bridge on account of its exceptional location.

Operation of draws in Cincinnati Southern and Kentucky and Indiana bridges.

Months.	Cincinnati Southern.						Kentucky and Indiana.
	1881.	1882.	1883.	1884.	1886.	1887.	1887.
January	1	24	15	32			
February	14	39	28	22		2	
March		4	23	23		1	17
April	4		13		4	1	
May		5				1	
June		1					
December			5				
Total	19	73	84	77	4	5	17

It is evident from the above record that the time for dispensing with draws in bridges 40 feet above high water has not yet come. It should be noted that 1882, 1883, and 1884 were years of very high water, the floods of 1883 and 1884 being without precedent.

DIKE AT BEAVER BRIDGE.

The Board of United States Engineer Officers that examined and reported on the plans for building a bridge across the Ohio River at Beaver, under date of August 15, 1877, recommended, as a condition for the acceptance of the site now occupied by the bridge, that a guiding dike 300 feet long be built in the prolongation up-stream of the left hand channel-pier. This recommendation was approved, and the railroad company, for whom the bridge was to be built, agreed to build the dike. After the bridge was under way the coal interest of Pittsburgh came to the conclusion that the dike as proposed was too short, and urged that it be extended to the shore, thus increasing its length from 300 to 918 feet. This recommendation was approved by this office under date of August 26, 1878, and also by the Chief of Engineers, and the Secretary of War accordingly ordered the railroad company to increase the length of the proposed dike to 918 feet.

In compliance with this order the engineer of the railroad company prepared plans for an extension of the dike and submitted them to this office for approval, which was granted. It was then supposed that the matter was settled, and that the dike would be built as desired by the river interest.

Work on the bridge was continued, and it was finally completed in the latter part of 1878, but no dike at all was constructed. On inquiry it was learned that the officials of the railroad company had concluded that the Secretary of War had no right to modify his original conditions after they had been accepted by the railroad company, and that, therefore, they were not legally bound to build the 918-foot dike. As to the 300-foot dike, they held that such a dike would be more injury than benefit, and that they would prefer no dike at all to one that did not extend to the shore.

This state of affairs was duly reported to the War Department by this office, with a suggestion that measures be taken to compel the railroad company to build the required dike. This communication was referred to the Department of Military Justice for report as to what action should be taken in the premises. The Acting Judge-Advocate General, in an indorsement dated July 19, 1879, gave it as his opinion that the Government had no power to compel the construction of the dike in question, and accordingly the Secretary of War ordered that a report of the facts be prepared for submission to Congress, which report was made under date of December 6, 1879.

No action was taken by Congress, and on November 7, 1882, I addressed a letter to the Chief of Engineers, calling attention to the fact that riprap and remains of old coffer-dams had been allowed to remain around the channel-piers of the Beaver Bridge in violation of the Ohio River bridge law, notwithstanding repeated notices to the company to remove these obstructions, and I recommend that legal proceedings be taken to compel obedience to the law. These papers were at once forwarded by the Secretary of War to the Department of Justice, and on the 23d of November the Attorney-General of the United States transmitted them to the United States district attorney for the western district of Pennsylvania, with instructions "to cause such action to be taken as may be deemed advisable for the protection and security of navigation of the Ohio River." Suit was accordingly brought in the United States court against the Pittsburgh and Lake Erie Railroad Company to compel them to remove the obstructions and build the guiding-dike.

While this suit was pending the railroad company, under date of January 25, 1883, requested the appointment of a Board of Engineer officers to examine the questions at issue, with a view to avoiding litigation. This Board submitted a report, dated October 25, 1883, in which they sustained the position previously taken by this office, and reported that the 918-foot dike was a necessity, and that the bridge company should be required to remove the obstructions around the piers.

The report of the Board embodied a promise from the railroad company to remove the riprap and old coffer-dams (which was subsequently done), and also a proposition to build the 300-foot dike originally ordered if the Board of Engineers considered it advisable, but making no allusion to the proposed increase of length to 918 feet.

This proposition was not acted upon by the United States, and the suit in the United States courts was continued until a decision was obtained in January, 1886. In this decision Judge Acheson held that the Secretary of War had exhausted his authority when he accepted the location of the bridge on *condition of the* construction of a 300-foot

Company addressed a communica
War, in which he claimed that the constructi
Beaver Bridge would be a serious obstruction to
his assertions by petitions from captains and pilo
boats.

The subject was again referred to a Board of E
sustained the views of its predecessors, and recom
dike be built above the left-hand channel-pier. I
recommendation the Secretary of War, on March
order for the construction of the dike.

After the receipt of this order the railroad comp
opposition, and commenced to build the dike. It
in November, 1887, ten years after the bridge was

Inquiries among navigators as to the effect of this
been favorable, one leading coal shipper having stat
of running the Beaver Bridge with a coal tow had
cent.

ESTIMATE.

In my judgment the time has now come for conti
provement of the Ohio River on the plans that are
tion at Davis Island. I have therefore inserted in
an item for two more movable dams. As navigatio
or less embarrassed during the construction of
thought it advisable to begin two dams at the sam
struct the river only half as long as if they were bu

The estimate provides for the purchase of sites a
of stone and other material.

Low dams and dikes .....
Commencing movable dams 2 and 3 .....
Obstructions in mouth of Licking .....
Snagging .....
Dredging .....
Removing wrecks .....
Office, inspection, engineering, and contin

Amount that can be profitably expended in the fiscal year ending June 30, 1890 ..... $1,151,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contracts for improving Ohio River in force during the fiscal year ending June 30, 1888.

Contractors.	Improvement.	Date.	To expire—	Remarks.
John J. Shipman	Dike at Four Mile Bar.	Nov. 28, 1884	Dec. 31, 1885	Extended to July 1, 1887, and completed.
I. V. Hoag, jr	Dike at Grand Chain	Dec. 1, 1884	do	Extended to December 1, 1888.
F. Gwinner	Grading and paving at Davis Island Dam.	Oct. 27, 1886	Dec. 31, 1886	Extended to August 31, 1887, and completed.
Crescent City Wrecking Company.	Removing Rocks at Grand Chain.	Dec. 6, 1886	Dec. 31, 1887	Completed.
Stephen D. Davis	Tow-boat for service with dredges.	May 31, 1887	do	Do.
I. V. Hoag, jr	Removal of bar at mouth of Licking River.	July 15, 1887	do	Do.
Cincinnati, Indianapolis, Saint Louis and Chicago Railway Company.	Embankment on south side of Great Miami River.	Dec. 21, 1887	Dec. 31, 1888	

COMMERCIAL STATISTICS.

Coal shipments from Pittsburgh during the year ending June 30, 1888. Prepared by Capt. Wm. Evans.

Month.	To Cincinnati.					To Louisville.				
	Trips.	Coal boats.	Coal barges.	Fuel flats.	Bushels.	Trips.	Coal boats.	Coal barges.	Fuel flats.	Bushels.
1887.										
November				40	140,000					
December				50	150,000					
1888.										
January	52	58	466	9	7,087,000	46	164	331	18	7,659,000
February	39	21	411	15	5,634,000	43	262	147	36	8,476,000
March	41	31	419	13	5,830,000	50	236	250	26	8,962,000
April	30	6	332	2	4,408,000	25	105	165	2	4,473,000
May	34	19	361	11	4,944,000	41	113	360	10	7,170,000
Total	196	135	1,989	140	28,193,000	205	880	1,253	92	36,740,000
Grand total										64,933,000

Col. Sidney D. Maxwell, superintendent of the Cincinnati Chamber of Commerce, in his last annual report, gives a full exhibit of the river commerce of Cincinnati, from which the following tables have been compiled:

River commerce of Cincinnati for the year ending August 31, 1887.

Articles.	Receipts.	Shipments.			
		To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Alcohol ..... barrels		5	97	185	287
Ale, beer, and porter ..... do		461	2,429	7,553	10,443
Apples, green ..... do	50,073	62	4,379	390	4,831
Bagging ..... pieces			6,232		6,232
Barley ..... bushels		50	780		830
Beans ..... do		74	878	1,756	2,708
Beef ..... pounds		137,500	10,010	1,210	148,720
Boots and shoes ..... cases		138	8,723	8,204	17,065
Bran, middlings, etc ..... tons		8	22	153	183
Broom-corn ..... pounds			2,250	21,250	23,500
Butter ..... tubs, firkins, etc			136	19	155
Candles ..... boxes		1,311	1,137	495	2,943
Castings ..... tons		241	494	592	1,327
Cattle ..... head	11,842	24	1,044	185	1,253
Cement and plaster ..... barrels	48,574	87	622	12,416	13,125
Cheese ..... boxes		5	1,595	3,113	4,713
Cider ..... barrels		196	771	146	1,113
Coffee ..... bags		26	8,887	10,993	19,906
Cooperage ..... pieces		18,693	585	187	19,465
Corn ..... bushels	107,420		1,406	107,201	108,607
Corn meal ..... barrels		15	340	2,941	3,296
Cotton ..... bales	47,006	17	729	1,197	1,943
Crockery ..... packages		259	1,873	1,017	3,149
Eggs ..... cases and barrels	46,607		22	89	111
Feathers ..... sacks			28	12	40
Fish ..... barrels		50	1,729	342	2,186
Fish ..... kegs and kits			1,959	1,127	3,081
Flour ..... barrels	4,348	375	6,392	39,746	46,513
Fruit, dried ..... bushels		25	1,768	2,487	4,280
Furniture ..... packages		3,046	9,622	8,335	21,003
Glass, window ..... boxes		2,916	1,774	1,132	5,822
Glassware ..... packages		10,690	27,051	4,433	42,172
Grease ..... tierces			18	10	24
Hardware ..... packages		1,068	25,788	12,405	39,266
Hay ..... bales	30,844			6,445	6,445
Hides ..... number			1,372	6,819	8,191
Hog product:					
Bacon ..... pounds		9,890	403,380	2,711,780	3,125,050
Bulk, loose ..... do			8,070	825,450	833,520
Bulk, in boxes ..... do			70,000	146,500	216,500
Hams ..... do		294,610	77,650	350,472	722,732
Lard, tierces ..... do		8,840	254,915	650,520	914,275
Lard, kegs ..... do		900	540	760	2,200
Pork ..... barrels		1,207	77	224	1,508
Hogs ..... head	49,939		761	3,825	4,586
Hops ..... bales			60	19	79
Horses ..... head		93	240	380	713
Iron and steel ..... tons		781	4,364	915	6,01[illegible]
Iron and steel, scrap ..... do			27	30	5[illegible]
Iron, manufactured ..... do	7,531				
Iron, pig ..... do	22,943		425	1,548	1,97[illegible]
Lead ..... pigs			28	112	14[illegible]
Lead, white ..... pounds		19,975	239,150	331,798	590,92[illegible]
Leather ..... bundles		5	547	1,137	1,68[illegible]
Lemons ..... boxes			658	992	1,65[illegible]
Lime ..... barrels			844	7,808	8,65[illegible]
Malt ..... bushels			19,350	14,083	33,43[illegible]
Manufactures ..... pieces		1,905	669	339	2,91[illegible]
Merchandise, sundry ..... tons		1,878	9,482	7,580	18,9[illegible]
Molasses ..... barrels	9,368	42	1,338	1,471	1,8[illegible]
Nails ..... kegs	374,472	17,181	245,721	1,206	264,1[illegible]
Oats ..... bushels			742	4,955	5,6[illegible]
Oil ..... barrels	24,296	401	4,144	4,733	9,2[illegible]
Onions ..... barrels and sacks		55	292	311	
Oranges ..... boxes			521	1,982	2,[illegible]
Peanuts ..... bags	23,427		2,109	2,810	4,[illegible]
Petroleum ..... barrels	9,291	3,195	14,337	1,102	18,[illegible]
Potatoes ..... bags and barrels	35,314	2,630	3,492	4,589	10,[illegible]
Rice ..... barrels		50	259	2,140	2,[illegible]
Rope, twine, etc ..... packages		359	7,829	1,690	9,[illegible]
Rosin ..... barrels			15	100	
Rye ..... bushels			5,208	2,346	[illegible]
Salt ..... barrels	139,202		46,275	497	4[illegible]
Salt ..... sacks			2	8	
Seed, grass ..... bags			3,126	8,092	1[illegible]
Sheep ..... head	26,848		66	35	

River commerce of Cincinnati for the year ending August 31, 1887—Continued.

Articles.	Receipts.	Shipments.			
		To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Shot ..... pockets..	.....	60	2,584	752	3,396
Soap ..... boxes..	.....	14,067	15,814	7,063	36,944
Spices ..... packages..	.....	.....	365	432	797
Starch ..... boxes..	.....	4,409	13,460	4,260	22,129
Sugar ..... hogsheads..	216	.....	40	45	85
Sugar ..... barrels..	317	.....	5,955	8,010	13,965
Tallow ..... tierces..	.....	.....	.....	18	18
Tobacco:					
Leaf ..... hogsheads..	25,132	47	1,469	219	1,735
Leaf ..... cases and bales..	.....	3	270	161	434
Manufactured ..... packages..	.....	281	4,398	7,355	12,034
Turpentine ..... barrels..	.....	.....	7	14	21
Vinegar ..... do....	.....	339	3,063	2,275	5,677
Wheat ..... bushels..	142,803	.....	732	10,649	18,381
Whisky ..... barrels..	55,078	2,053	6,272	7,219	15,544
Wines and liquors ..... do....	.....	199	347	119	665
Wines and liquors..baskets and boxes..	.....	844	958	1,277	3,079
Wool ..... bales..	.....	.....	488	1,233	1,721

The following tables, compiled from Colonel Maxwell's report, furnishes some additional information regarding the steam-boat interests of Cincinnati:

Arrivals and departures of steam-boats at the port of Cincinnati.

Ports of departure and destination.	1881-'82.		1882-'83.		1883-'84.		1884-'85.		1885-'86.		1886-'87.	
	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.
From New Orleans	68	.....	94	.....	63	.....	49	.....	63	.....	84	.....
For New Orleans	.....	79	.....	95	.....	70	.....	55	.....	66	.....	88
From Pittsburgh	169	.....	147	.....	114	.....	83	.....	103	.....	69	.....
For Pittsburgh	.....	164	.....	143	.....	111	.....	87	.....	103	.....	70
From other ports	2,499	.....	2,099	.....	1,993	.....	2,005	.....	2,323	.....	2,169	.....
For other ports	.....	2,496	.....	2,091	.....	1,981	.....	1,996	.....	2,314	.....	2,178
Total	2,736	2,739	2,340	2,329	2,170	2,162	2,137	2,138	2,489	2,483	2,272	2,281

Steam-boats landing at Cincinnati.

	No.	Tons.		No.	Tons.
1881-'82	214	78,793	1884-'85	205	65,261
1882-'83	217	75,344	1885-'86	196	63,998
1883-'84	198	68,312	1886-'87	168	53,616

Schedule of rates on flour per barrel, by rail or river, from Cincinnati, during the calendar year 1887.

How transported.	Pittsburgh.	Louisville.	New Orleans.
	Cents.	*Cents.*	*Cents.*
By rail	24 to 31	15	44 to 49
By river	15	15	35

	No.	Tons.	No.	Tons.	No.
1880-'81	4,196	1,124,836	1,220	377,055	503
1881-'82	3,964	904,343	1,793	537,906	750
1882-'83	4,954	1,226,455	1,294	398,240	179
1883-'84	4,346	1,070,650	1,384	432,575	301
1884-'85	4,886	1,217,231	708	231,695	95
1885-'86	5,057	1,254,342	1,296	406,619	393
1886-'87	4,768	1,157,250	1,793	991,974	667
1887-'88	5,471	1,315,851	1,514	863,237	361

For statistics of the commerce at the upper end of
s made to the report on operating and care of Davis

B B 2.

OPERATING AND CARE OF DAVIS ISLAND DAM,

The work still remains under the local charge of Mr
civil engineer, who has managed it with his custom
ciency.

The lock has remained in excellent working ord
year, the time of passing a fleet through being from t
utes. The only change proposed is to introduce spr
gate chains, so as to reduce the shock of starting. D
work of paving the terre-plein of the lock was compl

The operation of the dam has been less satisfactor
steel cross-heads of the navigable pass, of which mer
my last annual report, have continued to break. As
they have been replaced by wrought-iron ones, but i
ble to do this with all of them, as the long duration
tained such a pressure against the wickets that it w
out any of them in order to change the cross-heads

ing the risks of injury. It could have been lowered with perfect ease and safety at any time before the rise came, but such action would have caused the grounding and probable destruction of a large number of coal barges, and, in my view of the relations that should exist between navigation and a work built for its benefit, such a course was inadmissible. The Government, by creating the Davis Island pool, had invited coal shippers to use it for the accommodation of coal barges to await a rise in the Ohio, and it seemed imperative that these barges should be protected, and that all risks of injury and loss should be assumed by the Government.

With these opinions as to my duty in the premises, I issued orders that the dam should be kept up, notwithstanding the presence of ice in the pool, until a rise should come and release the impounded coal fleets.

When the ice-flood finally came, one of the special causes of embarrassment was the fact that the rise began on Sunday, and owing to the closure of telegraph offices it was impossible to secure reliable information that a rise was coming, coal operators themselves having concluded that the indications were unfavorable. Definite information did not reach the dam until 5 o'clock on Monday morning, at which time the rise was so near that operations were greatly hurried, and the failure of the usual methods of handling the dam left but little time to improvise others. For full particulars of the method of handling the dam under such conditions, and of the damages that were sustained, I would refer to the accompanying report of Mr. William Martin, the resident engineer.

As similar conditions are liable to prevail in the future, it is evidently necessary to utilize our past experience, and make such modifications in the structure as will make it as safe to handle the dam in ice-floods as in ordinary rises.

After careful consideration of the problem, I have concluded that it is necessary to modify the weirs, so as to permit them to be opened promptly and safely, when ice is running, without the use of service bridges or maneuvering boat. The only approved apparatus with which I am acquainted that will do this, and will do it with ease and certainty, is the Chanoine tripper.

It was the original design to use Chanoine hurters and trippers on the whole dam, but the use of this apparatus on the navigable pass would have lessened its width to a degree that was considered inadmissible by the river interests; and hence, after due consideration by a Board of Engineer Officers, it was decided to use the Pasqueau modification of the Chanoine hurter, whereby the pass could be made of any desired width, and the tripper could be wholly suppressed. This was a decided improvement, and I am still in favor of Pasqueau hurters in the navigable pass; but I think that recent experience shows that it was a mistake to extend the system to the whole dam. Wickets supported by props resting against Pasqueau hurters must be dropped *singly* from a bridge or maneuvering boat, operations which are impracticable in an ice-flood. On the other hand, if these same wickets are supported from Chanoine hurters, they can be dropped by working the trippers from the piers without the use of either bridge or boat, and the whole line of wickets controlled by one tripper can be dropped as quickly as a single wicket can be dropped where Pasqueau hurters are used.

It may be objected that the trippers used on the Great Kanawha passes have not been successful, and that the same thing will happen at the Davis Island Dam. To this I reply that trippers on high weirs

are much more accessible at all times than trippers in deep passes; that the floor of Weir 3 is out of water in low water, and that of Weir 2 is only 1 foot lower; that the pressure against the short weir wickets is much less than that against deep-pass wickets; that the length of Weirs 2 and 3 will only be 212 and 204 feet, respectively, when the piers are extended; and that advantage will be taken of the experience on the Great Kanawha, and all the parts that have proved too weak on that river will be strengthened. I ought to add that the engineers in charge of the Great Kanawha dams are decided in their opinions that there are no practical difficulties in working properly-proportioned trippers, and there are great numbers of such trippers which have been in successful operation abroad for many years.

It is my firm conviction that if the Davis Island Dam is equipped with a short bear-trap to remove drift, which will cause a widening of the navigable pass to over 700 feet by the addition of so much of Weir 1 as is not covered by the bear-trap, and is provided with Chanoine trippers on Weirs 2 and 3, it will be up to the highest known standard of efficiency, and can be handled in ice-floods without risk or annoyance to navigation.

Provision is made in the river and harbor bill just passed for the construction of a bear-trap, and the change from Pasqueau to Chanoine hurters will be made during the present season at the expense of the appropriation for "operating and care."

During the year the movable dam was up 201 days, and 712 lockages were made, passing 1,871 vessels, being an average of 2.6 boats to a lockage.

For further details, reference is made to the annexed report of the resident engineer.

The following table shows the commerce passing the dam during two years ending June 30, 1888.

Vessels passing the Davis Island Dam.	1886-'87.		1887-'88.	
	Through navigable pass.	Through lock.	Through navigable pass.	Through lock.
Passenger boats	414	55	336	36
Freight boats	83	9	34	9
Tow-boats	3,385	590	2,446	549
Model barges	306	14	121	.....
Coal-boats	1,520	42	1,752	100
Coal barges	8,141	451	6,322	352
Coal-flats	3,320	667	1,947	757
Rafts	53	7	56	7
Miscellaneous craft	95	67	50	61
Total	17,317	1,902	13,064	1,871
Number of lockages	.....	572	.....	712

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1888.

Month.	Office and general administration.					Lowering dam in ice-flood.	Repairs.				Grand total.
	Salaries.	Supplies.	Maps and drawings.	Miscellaneous expenses.	Total.		Labor.	Materials.	Tools and appliances.	Total.	
1887.											
July	$590.00	$74.54	.....	$227.85	$892.39	.....	$149.75	$2,345.83	$2.25	$2,497.33	$3,389.72
August	615.00	21.90	.....	13.72	650.62	.....	.....	8.00	4.75	12.75	663.37
September	615.00	18.85	.....	6.00	639.85	.....	.....	444.44	18.10	462.54	1,102.39
October	615.00	42.48	.....	8.20	665.68	.....	.....	1,522.38	.....	1,522.38	2,188.06
November	615.00	18.15	.....	8.33	641.48	.....	.....	67.25	38.64	105.89	747.37
December	608.83	21.25	$70.83	157.26	858.17	.....	.....	.....	6.23	6.23	864.40
1888.											
January	576.69	32.52	91.67	64.34	765.22	$1,189.56	49.00	5.90	31.20	86.10	2,040.88
February	565.00	19.85	125.00	.....	709.85	.....	.....	231.02	20.40	251.42	961.27
March	565.00	38.29	125.00	3.60	731.89	.....	.....	34.52	.....	34.52	766.41
April	615.00	30.15	125.00	2.00	772.15	.....	131.80	41.83	.....	173.63	945.78
May	659.00	27.55	75.00	40.45	802.00	.....	346.90	258.79	110.13	715.82	1,517.82
June	615.33	21.87	.....	144.73	781.93	.....	221.00	78.61	40.00	339.61	1,121.54
Total	7,254.85	367.40	612.50	676.48	8,911.23	1,189.56	898.45	5,038.07	271.70	6,208.22	16,309.01

Estimate for 1888–'89.

1. Salaries	$7,415	9. Extra labor	$300
2. Gauge reports	400	10. Well on Davis Island	125
3. Telephone	240	11. Riprap protection below dam	2,000
4. Natural gas for fuel	325	12. Changing hurters on weirs	5,000
5. Oil, lines, oars, and other supplies	650	13. Post-office box	8
6. Repairs to props	327	14. Contingencies	1,000
7. Repairs of lock-gate chains	125		
8. Minor repairs	100	Total	18,015

REPORT OF WILLIAM MARTIN, ASSISTANT ENGINEER.

Terre-plein of lock.—At the close of the last fiscal year the paving of the area in the land-wall inclosure was complete, excepting about 300 square feet. This deficiency is now finished, thus completing a paved surface 37 feet wide by the length of the lock. The paving consisted of square blocks of stone of various sizes, 12 inches deep and laid dry, and having the surface spread with gravel 2 inches deep. Once during the year the river overflowed this paved surface, and filled the spaces between the paving stones with the surface gravel, making a strong bond and smooth surface.

The area between the paved surface and the embankment of the Pittsburgh, Fort Wayne and Chicago Railway, a width of 90 feet, was uniformly graded and sown with grass seed. The soil is not the best adapted for vegetation, but when the lock force will have more time to devote to the care of the grounds they can be made very attractive.

Cross-heads of wickets.—During this, as in past years, the defective steel cross-heads of the horses in the navigable pass have caused much labor and annoyance. In the month of July a wicket, which had its cross-head previously broken, was planked over, thus throwing its pressure on the two adjacent wickets. This additional pressure broke the cross-heads of these adjacent wickets, thus making a gap in the dam 12 feet wide, which was too great for planking, as the cross-heads of the adjacent wickets would be less likely to support the gap of three wickets than of one. It became necessary to draw the pool off for a period in order to replace the broken parts; this action greatly inconvenienced the business in the harbor, and gave rise to much complaint. To avoid a repetition of these occurrences, it was decided to procure wrought-iron cross-heads to replace all the steel ones in the pass. This work has been going on from time to time as circumstances would permit; 64 of the cross-heads have been renewed.

Operation of lock gates.—The working of the steam-engines for operating the lock-gates during the time the dam was up was very satisfactory; no fault can be found with the system or any of the details. The speed with which a lockage can be made with tows equal to the capacity of the lock gave great satisfaction to the boatmen. From ten to twelve minutes is the average time required to pass a tow through the lock if the boatmen are prompt in handling their boats. During the year no trouble was experienced with débris accumulating in the gate recesses, or with the lock-gates, save the breakage of one of the vertical posts on the lower lock-gate, which carries a friction-wheel. The broken post was renewed by a heavier one. The breaking of this post permitted the gate to have too much lateral motion, and allowed the gate-wheels to travel off the iron rail in the gate-sill and become embedded in the timber. When the water-pressure was applied to the gate, forcing it to its seat, the lower outer gate-wheel caught on the rail, bending the axle slightly, but not enough to prevent its working. A new axle has been procured to take the place of the bent one, should the latter break.

Operation of dam.—The dam was up at the beginning of the fiscal year, and remained up until the 2d day of January. This long period of low water was very exceptional, as the fall rises in the river usually occur in October or November.

During the month of December the pool was frozen over twice, viz, on the nights of the 22d and 29th. On the latter date it was frozen to a thickness of 3 inches.

On the night of December 31 heavy rains fell at all points in the water-sheds of the Allegheny and Monongahela rivers. At many points the fall exceeded 1½ inches, and at some places it was nearly 2 inches, but the rains had very little effect upon the river, as all reports indicated an insufficient rise for barge water. This also was the general belief among coal operators, many of whom had abandoned the idea of getting out any coal on the water expected. On January 1 the steam-boat *George Wood* broke the ice in the pool between the dam and Pittsburgh. Anticipating the necessity of putting the dam down, it was deemed safer to have the ice broken than to permit it to strike the dam in large floes. The correctness of this theory we were unable to demonstrate, as the ice in both rivers broke, and the flood was upon us without warning. We immediately proceeded to lower the dam in the usual manner, *i. e.*, by beginning at the Davis Island or weir end. By so doing the pool is lowered, and the work on the navigable pass, which is done from the maneuvering boat, is made safe. After twelve wickets had been lowered, the strong current, caused by the opening, drew into it a great mass of drift-wood and ice. Amongst the drift-wood was the side of a coal-flat, which formed a gorge against the service bridge, making it equivalent to a solid dam. The consequent pressure against the service bridge endangered its safety to such an extent that the operators quit the work of lowering the wickets, as it was feared that a continuance of this work might result in the total destruction of the bridge. The work of opening the weirs being suspended, the fall at the dam still remained too great to use the maneuvering boat in lowering the navigable pass.

Ice flood.—Believing that with the running ice in the river it would be impossible to lower the dam with our maneuvering boat in the usual manner, *i. e.*, by resting it above the dam, the precaution was taken to procure a steam-boat with a flat lashed to her bow. With this equipment, as on a former occasion, we expected to be able to lower the dam by working from below, but on account of the high wind and the heavy ice, which had now begun to flow over the dam, the steam-boat only succeeded in lowering half a dozen wickets. On account of the high winds, which continued to prevail, it was evident we could not succeed in lowering the dam in this manner, as the steam-boat could not hold herself straight. I immediately telephoned to Pittsburgh for two steam-boats, having a barge lashed between them. These boats with the barge, arrived promptly, and by having the barge between them they were able to keep themselves straight in the current and lower all the wickets except ten which were scattered at equal intervals across the pass. These wickets were swung on their axes, having their breeches turned up, and it was impossible to lower them by the barge, as it drew less water than the depth flowing over the wickets.

A propeller drawing 5½ feet of water was then procured, but after several ineffectual efforts to push down the wickets nearest to the river-wall, we had to abandon the attempt. The cause of this failure developed on Wednesday morning, the 4th of January, when the steamer *Beaver* was ascending light and the *Little Bill* was descending with three coal boats. A conflict of signals compelled the *Little Bill* to go out from the river lock-wall further than it otherwise would, and resulted in the tow striking the nearest standing wickets, knocking them from their fastenings in the foundation. After the tow struck the wickets, a large log floated to the surface. This log had kept the wickets standing. The propeller had tripped the props, but the log, being between the wickets and their horses, prevented them dropping to their bearings on the foundation.

The accident to the *Little Bill*, striking the wickets nearest the lock-wall, cleared an opening in the pass from the river lock-wall of about 300 feet, and this width was sufficient to enable tows of all sizes to pass through with safety.

The damage to the dam was not great, as has been shown by the actual repairs made, and much of this damage can be attributed to causes other than the ice.

On the 15th of January, when the river had fallen to a stage of 6½ feet, a tow-boat was employed to assist in lowering the undamaged wickets yet standing and in removing the damaged wickets which were standing above the sill of the dam. Ten wickets with their props bent were removed, making navigation through the pass safe.

Repair of damages.—As winter had set in, and a high stage of water was likely to remain for an indefinite period, it was considered prudent to postpone any attempt at repairing the damage done until spring, when lower water would facilitate our work, and when the work of repairs would not interfere with navigation. We accordingly began the repairs on the 1st of May, and progressed favorably, with three interruptions due to high water, completing everything by June 15.

Causes of damage.—The damages were confined to the navigable pass, and are attributed to ice, defective steel cross-heads, and damages by steam-boats.

Damages by ice.—Two broken wickets, 22 bent props, 4 broken props.

Damages by defective cross heads.—Five broken hurters, 37 broken cross-heads, 1 broken anchor-bolt, 1 broken horse-box, 4 broken wicket-boxes, 4 lost wickets.

Damages caused by steam-boats employed in lowering dam.—Three broken horses, 23 broken quoins.

Damages by steam-boat collision.—Three broken props, 3 broken horse-boxes, 3 broken anchor-bolts.

I firmly believe that the delay in getting the dam down caused a saving to the coal operators vastly larger than the loss they may have sustained by reason of not getting to the lower markets as soon as would have been the case if no delay had been caused the dam.

No coal had left Pittsburgh for the lower markets for a long period, viz, six and one-half months, and in consequence the operators were eager to make shipments. In many cases which I observed, the ice had gorged beneath the boats, grounding them in 12 feet of water. If they could have gone out with the rise without any delay, this ice under the barges would have caused a vastly greater injury, through wrecked barges and loss of coal, than that sustained by delay in getting to the lower market. Several of the coal operators have also expressed themselves to me to this effect.

Maneuvering boat.—On the evening of January 3, during the break up in the river, we were taking our maneuvering boat through the lock to a place of safety below the dam, when it was caught between a descending coal-tow and a grounded steam-boat at the lower guiding-dike, crushing it so as to sink it. We recovered the wreck 1 mile below the dam. The steam engines and boiler, hooks, lines, and other tools were saved, but the boat was a total loss.

A new boat of better appointments and larger dimensions, viz, 50 feet long, 16 feet wide, and 3 feet deep, was built as soon as practicable. The steam-engine and other equipments belonging thereto were placed on the boat, and in addition a derrick was mounted on the bow for removing the injured parts of the dam and putting the new parts in place. This derrick will also be useful as a permanent fixture for replacing props that get out of the hurters, and for doing other work requiring heavy lifting.

Natural gas.—Our supply of natural gas is now received from the Fort Pitt Natural Gas Company, whose wells are located about 12 miles distant. The gas is conducted through a 10-inch main to a point three-fourths of a mile distant from the dam, thence it is conducted by a 2-inch pipe to the dam, and attachment is made with the Government system of pipes, which convey it to the points of consumption, viz: One steam-boiler at the upper lock-gate, one steam-boiler at the lower lock gate, one steam-boiler in the pump-house at the rear of the lower gate recess, three torches on the land lock-wall for general illumination (one at each lock-gate, and one in the center of the lock in front of the lock-keeper's house), one heating stove in the workshop, and one fire-place in the office.

On the Davis Island end of the dam we have one torch elevated 25 feet, which gives general illumination on the dam. The gas for this torch is received from the Philadelphia Natural Gas Company (formerly the Chartiers Natural Gas Company).

By the use of natural gas for fuel the labor that would be necessary to convey coal to the various points of consumption is saved, as well as the cost of trucks, wheel-barrows, etc., for handling it. Assuming that the cost of coal was equal to that of gas at the point of consumption, the use of the latter would result economically, as the gas requires no attention after it is once turned on. To successfully use coal, the fire would have to be kept up in the boilers of the engines for operating the lock-gates when the dam was up, and considerable attention of a fireman would be necessary. With gas, steam can be kept up with very little attention, and the fireman or engineer can have much time to devote to other work. The same advantage will apply to the other fires.

Danger signals.—When the dam is down red signals are placed as follows: One on

the pier at the junction of the navigable pass and Weir No. 1; three at the head of the river lock-wall, placed on a mast, 5 feet apart vertically, and two in a similar manner at the foot of the wall. When the dam is up, one red signal is placed on the upper end of the upper guiding-crib and one on the lower end of the lower guiding-crib. Should there from any cause be no natural-gas torches on the land lock-wall, one red signal will be placed on each end of the river wall.

Cross currents below the lock.—The guiding-crib below the lock is 250 feet long. This length is insufficient for large tows to enter the lock easily. The eddy, caused by the lock and the lower gate recess, creates such an inset of the current towards the guiding-crib as to bind the boats against the crib, making it difficult for them to enter the lock. This crib should be extended down the river about 400 feet, and be built to a height of 11 feet and 6 inches, making the total length of the crib 650 feet.

Riprap below the dam.—Since the construction of the dam there have been placed below the foundation about 5,686 tons of riprap stone, for the restoration of the river-bed and the protection of the foundation from injury by scour. This stone in most places is in good condition. All the voids between the stones have been filled with gravel, making a smooth surface, but there are places which require an additional quantity of stone to bring the river-bed up to a proper height to insure safety from further scour. I would recommend that the work be done as soon as possible.

Flexible gate-chain connection.—In starting the lock-gates there is a very severe strain on the chains, owing to the rigid connections between the chains and gates. To overcome this a flexible connection or tug-link should be attached to the gate end of each chain. This will save the chains from injury, and add considerably to their durability. Four tug-links will be required.

Drift-wood.—In this, as in past years, much hard labor was necessitated to prevent the large accumulation of drift-wood from becoming entangled with the wickets and the lower parts of the dam. It is encouraging, however, to know that in the pending river and harbor bill provision is made for the construction of a bear-trap gate in Weir No. 1, for the purpose of freeing the dam of this obstruction. This bear-trap gate, in addition to being useful in ridding the dam of drift-wood, will be valuable for controlling the fluctuations of the pool.

The movable dam has been up during the year two hundred and one days, viz:

	Days
From July 1 to January 2, inclusive	187
From June 17 to June 30, inclusive	14
Total	201

B B 3.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

Work was carried on vigorously during the season of 1887, which was an exceptionally favorable one for work, and at the close of 1887 the condition of the work was as follows:

The masonry of the river-wall of the lock was completed.

The masonry of the land-wall and the wing-wall was completed, except the coping, in which a deficiency was discovered, and work had to stop until additional coping-stones could be procured.

The abutment is completed, except the central T; the wall that prolongs the abutment to the mouth of Dunkard Creek has also been finished.

All of these structures are founded on rock.

To complete the improvement at this place it yet remains to finish the lock, and then to build the dam. The latter work has not yet been begun, and the following yet remains to be done on the lock: laying coping of land-wall; building and hanging lock-gates; construction and placing of valves and general operating machinery; construction of guide-cribs; filling and paving behind land-wall.

For further details reference is made to the report of Mr. P. J. Schopp, the resident engineer.

Money statement.

July 1, 1887, amount available		$84,095.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$32,152.95	
July 1, 1888, outstanding liabilities	2,080.34	
		34,233.29
July 1, 1888, balance available		49,861,97
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		84,861.97

The following statistics, taken from the annual reports of the Monongahela Navigation Company, show the commercial movements on the lower or northern end of the river for five years, ending December 31, 1887:

Articles.	1883.	1884.	1885.	1886.	1887.
Brick.....number..	1,806,161	652,126	588,892	3,998,802	2,346,223
Cattle and horses.....do.....	766	289	998	1,029	1,357
Classified freight.....pounds..	35,179,470	27,779,991	27,365,266	26,171,201	32,972,756
Coal, coke, and slack..bushels..	112,395,389	81,706,852	85,923,107	113,099,147	78,912,900
Fire clay.....tons....	5,794	2,140	3,463	3,295	2,383
Hogs.....number..	.....	3,381	1,845	1,105	3,451
Iron ore.....tons..	31,681	20,840	16,486	17,823	17,683
Iron in pigs.....do....	785	17	11½	5	7
Lumber.....feet..	11,759,890	7,142,447	6,414,212	6,820,804	7,429,350
Oil.....barrels..	1,479	52	1,073	.....	307
Pipe.....tons..	.....	.....	595	.....	2,285
Posts.....number..	2,800	255	12,826	21,853	12,886
Posts, pit.....do....	252,905	219,200	201,040	114,950	190,450
Railroad ties.....do....	57,000	16,750	1,800	2,150	400
Sand.....bushels..	733,700	679,000	941,300	1,076,900	1,622,000
Sheep.....number..	.....	5,677	4,464	3,600	7,771
Sheep and hogs.....do....	11,017	.....	.....	.....	.....
Staves.....do..	135,000	.....	4,000	4,000	.....
Steel rails.....tons..	43,946	23,844	22,428	45,795	57,490
Stone.....perches..	15,635	32,067	4,350	2,641	520
Timber.....feet..	3,635,624	2,091,740	2,052,100	2,342,146	2,380,490
Whisky.....barrels..	5,719	6,770	5,293	4,374	1,317
Wood.....cords..	32	.....	120	102	.....
Passengers.....number..	26,058	26,871	24,698	26,885	50,584

For statistics of the commercial movement on the upper end of the river see report on operating and care of Lock and dam No. 9.

REPORT OF P. J. SCHOPP, ASSISTANT ENGINEER.

From the beginning of the fiscal year, July 1, 1887, to the close of the working season on December 13, 1887, little interruption occurred, the weather and stage of water being very favorable for the work. In 1888, work was resumed on the 5th of June.

During the year the masonry of the river-wall of the lock was completed, and is now ready to receive the machinery for operating the gates; the top of the wall is 26 feet above the top of the lower miter-sill, and it has an average depth below the sill of 6 feet, depending on the levels of the bed-rock.

The land-wall of the lock was built to a height of 24 feet above the lower miter-sill, and it is now ready to receive the coping; when finished the total height of the wall will also be 32 feet.

The wing-walls, connecting the lock with the shore, were also finished and made ready for the coping. They are as high as the lock-walls.

On the lock 3,791 cubic yards of masonry were laid during the working season.

On the left bank of the Monongahela River opposite the lock, it was necessary to build an abutment for the proposed dam. As bed-rock is about 12 feet below the low-

[illegible] was entirely finished. Its top is [illegible]
[illegible]e of Pool No. 7, and the total height of this wall fro[illegible]
[illegible]he abutment is raised to its final height of 32 feet fro[illegible]
in the center, 10 feet higher, and rising to a height of 42 f[illegible]
to be finished.

The amount of masonry laid on the left bank of the riv[illegible]
2,052 cubic yards, of which 1,344 cubic yards is in the abu[illegible]
in the retaining-wall.

During the winter months plans were prepared for the p[illegible]
and lower gates.

B B 4.

OPERATING AND CARE OF LOCK AND DAM NO. 9, M[illegible]

The work was in operation during the whole of th[illegible]
of commerce is small, as the lock can not be reach[illegible]
this will continue to be the case until Lock and[illegible]
pleted.

During the year the apron below the dam, bui[illegible]
tinued across the river to the abutment, greatly stre[illegible]
and removing all danger of undermining from th[illegible]
rock. The original length of apron was 106 feet,[illegible]
294 feet, making a total length of 400 feet. Whe[illegible]
the deepest water it has a height of 29 feet, and [illegible]
feet deep at low water on an irregular bottom co[illegible]
of rock. The down-stream face of the crib is half[illegible]
with riprap.

The top of the filling is covered with concrete, [illegible]
a close sheeting of 12-inch white oak, having a s[illegible]
width of the apron. The structure is firmly bolte[illegible]
the dam, and the declivity from the crest of the d[illegible]
of the apron is 1 on 4. The work [illegible]

Detailed statement of expenses incurred at Lock and Dam No. 9, Monongahela River, during the fiscal year ending June 30, 1888.

Month.	General administration.			Equipment.	Repairs.				Grand total.
	Salary of lock-keeper.	Miscellaneous expenses.	Total.		Labor.	Materials.	Freight.	Total.	
1887.									
July	$33.33	$22.45	$55.78	$22.44	$252.34	$418.40	$77.55	$748.29	$826.51
August	.....	.....	.....	5.82	1,138.13	5,751.82	56.45	6,946.40	6,952.22
September	13.33	15.75	29.08	28.09	946.39	1,159.69	53.68	2,159.76	2,216.93
October	50.00	.....	50.00	.....	.....	27.17	.60	27.77	77.77
November	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
December	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
1888.									
January	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
February	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
March	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
April	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
May	50.00	.....	50.00	.....	36.71	.....	.....	36.71	86.71
June	50.00	.....	50.00	.....	95.16	290.00	.....	385.16	435.16
Total	496.66	38.20	534.86	56.35	2,468.73	7,647.08	188.28	10,304.09	10,895.30

ESTIMATE FOR 1888–'89.

Repair of lock-walls	$5,770
Operating lock	700
Total	6,470

COMMERCIAL STATISTICS.

Lock No. 9 is still without connection with the slackwater system on the lower river, and the business done through it is small compared to what is expected upon the completion of No. 8.

The commerce at No. 9 during the past year was as follows:

Commerce passing Lock No. 9, Monongahela River, during the fiscal year ending June 30, 1888.

Date.	Lockages.	Up.			Down.				
		Barges and flats.	Miscellaneous.	Merchandise.	Barges and flats.	Rafts.	Miscellaneous.	Lumber.	Timber.
1887.	*No.*	*No.*		*Tons.*	*No.*	*No.*	*No.*	*Ft., B. M.*	*Cub. ft.*
July	14	.....	6	7	.....	.....	6	.....	.....
October	2	.....	1	.....	.....	.....	1	.....	.....
November	1	.....	1	.....	.....	.....	.....	.....	.....
December	1	.....	.....	.....	1	.....	.....	.....	.....
1888.									
January	3	.....	.....	.....	1	2	1	.....	4,300
February	6	1	3	25	1	.....	3	.....	.....
March	60	2	4	6	2	56	2	201,000	225,000
April	16	2	4	12	2	7	2	41,000	13,000
May	32	3	8	35	1	22	6	50,000	60,200
June	3	.....	2	.....	1	.....	.....	.....	.....
Total	138	8	29	85	9	87	21	292,000	302,500

B B 5.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

Owing to the failure of the river and harbor bill in 1887, work on this river was limited to the expenditure of the small balance ($6,850.23) left over from the season of 1886.

With these funds the dam at Corydon was improved, the dams at Nicholson's and Six-Mile were repaired, and some rocks were removed.

The Corydon Dam, built for milling purposes, had a vertical lower face, with a fall of 3½ feet. At ordinary rafting stages this dam was a dangerous obstruction, frequently causing loss of property and, occasionally, of life. It was modified by adding crib-work along the lower side of the dam, whereby the vertical face was replaced by a gently inclined slope, with a fall of about 1 foot in 6. Since the change there has been no trouble at the dam, and raftsmen express themselves as being well satisfied with the work and its results.

At the Nicholson and Six-Mile dams the stone filling in a number of squares of the down-stream slopes had been torn out, and at the latter dam an ice-gorge had caused a break of 60 feet in width. This last was repaired, and at both dams the paving of the refilled squares was strengthened by filling the joints with cement mortar; afterward the joints of the entire lower slope of each dam were similarly treated. The problem of holding the paving of the lower slopes of dams of this kind is a troublesome one, and if this experiment succeeds on a river like the Allegheny, where ice moves with unusual force, it will doubtless answer on other rivers. As far as I know, no damage occurred during the past winter.

About 540 tons of rock were removed from the bed of the river.

ESTIMATE.

The chief rock obstructions in the Allegheny being now removed, it is proposed to expend such funds as may hereafter be appropriated in closing duplicate channels by low dams, and in contracting the low-water channel by guiding-dikes wherever excessive widths cause shoaliness. The experimental dams at Six-Mile Island and at Nicholson's have shown that this can be successfully done, notwithstanding the fact that ice-gorges are a marked feature of this river. The sum of $50,000 can be profitably expended on this class of work.

Money statement.

July 1, 1887, amount available	$6,850.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,190.90
July 1, 1888, balance available	659.33
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,659.33
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

REPORT OF J. W. ARRAS, ASSISTANT ENGINEER.

The project for 1887 contemplated the erection of a log chute in the dam at Corydon, Pa., 209.3 miles above Pittsburgh; the repairs of dams at Nicholson's and Six-Mile islands, and the continuation of the work of clearing the channel of rocks and other obstructions.

The chute designed to give safety to the passage of rafts over the Corydon Dam, which has hitherto been attended with fatal results both to life and property, comprises a system of crib-work ballasted with stone, paved with same to the depth of 1 foot, and covered with heavy oak sheeting. The structure is 16 feet wide, and extends along the entire lower wall of the dam, a distance 377½ feet. Its average height is 11 feet, and the slope of the top varies from 1 foot on 5 feet to 1 foot on 8 feet; 311½ linear feet of the sheet covering is 6 inches thick, and 66 linear feet 3 inches in thickness. The construction of the chute was begun in July, and the work was completed in September, 1887, at a total cost of about $5,000.

On the Nicholson Dam all paving and backing displaced by the frequent heavy ice-gorges of the past winter was restored. This work was done with the material scoured out, which was all recovered. To more effectually resist the action of heavy ice flows, and of the water during floods, the paving of the entire lower slope of the dam was filled with cement grout. The area grouted was 2,530 square yards, and the total cost of the repairs was $497.16.

The Six-Mile Dam, it was found, had sustained serious damage during the winter. Scour below a portion of the dam had impaired its strength at that point, and a breach 60 feet wide was cut through the entire work by a heavy ice-gorge. The rip-rap extension on the head of the bar had also been carried away for a distance of 60 feet. This work was renewed, all damaged paving restored, and the paving of the rear slope of the dam strengthened with cement grout. Total cost of repairs, $701.24.

The work of removing rocks from the river-bed was also carried on, but owing to the limited amount of funds remaining for this purpose, efforts were confined to improving such points as were then deemed most dangerous to navigation.

The following is a statement showing the localities worked over and the work done:

Above mouth.	Place.	Rocks removed.	Weight.
Miles.		*Number.*	*Tons.*
188.9 188	Glade Run to Warren	14	51
170	Mill Stone	69	132
160.5	White Oak Chute	81	217
137.5	Walnut Bend	1	6
86	Foxburgh	1	7
57.5	Mahoning	33	127
	Total	199	540

Sketches of the following troublesome ripples were made with a view to their future improvement:

Gilman's Ripple, 204 miles from mouth of river.

Mill Stone, 170 miles from mouth of river.

Hickory Ripple, 158 miles from mouth of river.

Among the notable results of the improvements to navigation on the Allegheny already made is the establishment of a regular packet trade between Pittsburgh and Kittanning, a distance of 45 miles. Upon the breaking of the ice, early in March, the steamer *Nellie Hudson* was put in operation, and made daily trips between these points until the low water of the latter part of June set in. The recent slight rises have enabled her to resume the trade. This effort to supply a long-felt want is duly appreciated by the various industries within its reach. But while the enterprise is a step toward the desired end, it also but little more than tends to show, by a comparison of its capabilities with the immense demand for transportation by water, the necessity for, as well as the ultimate result of, permanent and reliable water facilities.

Much remains yet to be done on this river that would be of great benefit to navigation, and the fact that in securing greater safety to the shipping interests through the improvements already made much general good has been done, which is apparent from a steadily-growing commerce, increased activity of the industries along the valley, and the establishing of a new enterprise, notable among which is the erection, near Kittanning of what is claimed to be the largest plate-glass factory in America, should encourage a speedy continuation of the work under way.

COMMERCIAL STATISTICS.

It is impracticable to procure complete statistics of the commerce of this river, as no record of the trade is kept, and I am therefore able to present only a statement of the principal items of the extensive trade carried on, which has been compiled from reports of shipments during the year ending June 30, 1888, furnished by a number of the more prominent operators of the valley.

Articles.	Number or quantity.	Articles.	Number or quantity.
Barges.....number..	75	Paving stones (cobbles).cubic yards..	5,400
Bark.....cords..	2,967	Railroad-ties.....number..	80,000
Boat bottoms.....number..	1,025	Stone.....cubic yards..	7,000
Fire-clay.....tons..	1,200	Rough lumber.....feet, B. M..	138,000,000
General freight.....pounds..	1,800,000	Sand.....bushels..	1,000,000
Hay.....tons..	1,400	Timber.....cubic feet..	6,211,500
Passengers.....number..	1,700		

These statistics are approximate, and cover only the principal items of the vast trade carried on. For the information from which they are made up I am indebted to the more extensive operators of the valley, and to Messrs McVay and Oakley, of Allegheny City, timber measurers.

No attempt at an estimate of the minor trade of the Allegheny, although vast in the aggregate, has at this time been made, as all efforts in that direction during the past have been futile, owing to the fact that the territory over which they are scattered is so great and that no record of them is anywhere kept. The articles embraced in these latter are dressed lumber, shingles, laths, staves, barrels, posts, poles, piling, etc., and limestone, iron ore, coal, bricks, glass, gas-pipe, oil, etc.

An important feature also of the commerce of the Allegheny is its local harbor trade at Pittsburgh. Although irregular in its character, I am able to give a few of the more extensive commercial movements, viz: One hundred and fifty thousand railroad-ties annually transferred to the Allegheny Valley Railroad, over 1,500,000 bushels of sand, and more than 100,000 baskets of vegetables and market produce shipped by the steamer *Two Brothers*.

B B 6.

LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

Since last year's report the obstacle to beginning work at this locality has been removed by the act of Congress approved April 24, 1888, authorizing the Secretary of War, in the name of the United States, to acquire, by condemnation or purchase, any land, right of way, or material necessary for the prosecution of work for the improvement of rivers and harbors for which provision has been made by law.

A surveyor has been employed to plat the boundaries of the properties adjoining the Herr's Island lock and dam, with a view to selecting the quantity needed for this work, and the United States attorney for the western district of Pennsylvania has been directed by the Attorney-General to render such legal assistance as may be necessary in connection with the acquirement of the same by the United States. Drawings of the proposed lock have been prepared.

ESTIMATE.

As the building of locks in a river subject to floods is a somewhat hazardous undertaking, and as economical conditions require that it should not be unnecessarily prolonged, it is essential that the progress of the work should not be checked by scarcity of funds. I therefore submit an estimate for the next fiscal year of $100,000.

Money statement.

July 1, 1887, amount available		$37,340.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$491.55	
July 1, 1888, outstanding liabilities	256.45	
		748.00
July 1, 1888, balance available		36,592.00
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		71,592.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		100,000.00

B B 7.

ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

This ice-harbor is Pool No. 1 of the Muskingum River, and the work that is under way is the construction of a large lock in the lowest dam of the Muskingum River, with a view to permitting Ohio River craft to take refuge in this pool whenever circumstances may make such a course advisable. The work has been in progress since 1880, having been greatly delayed on account of inadequate appropriations and the fact that no appropriations at all were made in either 1883, 1885, or 1887. It is now about two-thirds completed.

As stated in my last annual report, it was considered best to do as much as possible with the funds on hand, inadequate as they were, rather than delay the work longer; and accordingly work was resumed in June, 1887. The coffer-dam around the finished part of the lock was extended so as to include the whole lock, the new section was pumped out and excavated to grade, all of the bearing-piles were driven, the lock-floor was laid, and as much of it was covered with concrete as the available funds would justify. At the close of the season nearly half of the concrete yet to be laid had been put in place, preference being given to the portion of the floor nearest the bank. No masonry was laid.

It is greatly to be regretted that this work has been prosecuted in so uneconomical a manner, but circumstances made it unavoidable. The cost of preparing for a short season's work, and of dismantling and protecting property against spring floods after the season is ended, make heavy drafts on the available funds, and show no results in the finished structure. As far as I now know the coffer-dam and floor laid in 1887 are in good condition, but definite information can only be obtained after work is resumed. The whole lock is about two-thirds completed, but it will progress much more rapidly after the foundations are finished.

The work, as usual, has been under the very efficient charge of Mr. William Weston, assistant engineer, and reference is made to his report for information as to details.

Money statement.

July 1, 1887, amount available	$27,851.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	26,689.27
July 1, 1888, balance available	1,162.46
Amount appropriated by act of August 11, 1888	60,000.00
Amount available *for fiscal year ending June 30, 1889*	61,162.46

REPORT OF WILLIAM WESTON, ASSISTANT ENGINEER.

Arrangements having been made for the supply of material needed for the construction of the coffer-dam at the Marietta Lock, a small working force was started on June 20. Owing to delay in receipt of material, no work towards the construction of coffer was done until July 5. From this time operations were carried on without delay until the exhaustion of the available funds, November 18, 1887. The average working force for the season was about 75 men.

The work accomplished during the season was as follows:

The construction of 300 lineal feet of coffer-dam, and unwatering it, from the 25th of July to the 11th of November; 10,700 cubic yards of excavation made for the lock-chamber; 1,474 bearing piles driven and capped for lock-floor and lock-walls; 63 protection piles driven to secure bank; 150 lineal feet of machine-driven sheeting piles; 2,150 square feet of lock-floor laid; 688 cubic yards of concrete put in place, covering 9,250 square feet of lock-floor.

All material, except cement was purchased in open market by accepting lowest offers from responsible bidders. The price paid for material delivered at the yard was as follows:

Round piles for coffer-dam, per lineal foot.	$0.09	Floor bolts, per pound	$0.041
Square piles for coffer-dam, per 1,000 feet B. M	16.00	Cast washers, per pound	.026
Oak plank for coffer-dam, per 1,000 feet, B. M	15.50	Riprap for concrete, per cubic yard	.84
Foundation piles, white oak butts, per lineal foot	$0.13½ to 15	Gravel for concrete, washed, per cubic yard	.99
White oak timber and planks for lock-floor, per 1,000 feet B. M	18.00	Sand for concrete, per cubic yard	1.25
		Coal, Cambridge, run of mine, per bushel	0.06
		Natural cement, per barrel	$1.33 to 1.48

B B 8.

OPERATING AND CARE OF THE LOCKS AND DAMS ON THE MUSKINGUM RIVER, OHIO.

The work of operating and maintaining the works on the Muskingum River has been under the local charge of First Lieut. L. H. Beach, Corps of Engineers, assisted by First Lieut. C. E. Gillette, Corps of Engineers.

When the last Annual Report was forwarded, the United States had had charge of these locks and dams for less than three months, and the time had been employed in organizing a force of lock-keepers, and in accumulating men and material for work as soon as the condition of the river would permit.

While several of the locks were in very bad condition, the dams were so much more dangerous that our main efforts were directed to repairing the worst places, so as to maintain continuous navigation. In this we were successful beyond our expectations, and no dam let go during the fiscal year. Our success was chiefly due to a phenomenal season of low water, which lowered the pools so that all of the dams were out of water. More or less repair was put on all of them, but very heavy work was done on dams 1, 2, 4, 5, and 8. All such structures on the Muskingum River are built with steps, though without any regularity as to height or down-stream slope. Wherever circumstances permitted, I have replaced these steps by slopes of 1 on 3 or 4, with a 10-foot horizontal step at the foot of the slope. The effect of such construction has been to get rid of the shock of ice, and to cause a deposit at the foot of the dam, the deep scour that forms below all dams being pushed so far from the foot of the dam as not to endanger its stability. The experience of last year has fully demonstrated the great advantage of this form of dam.

Lock No. 9 was in imminent danger of falling down; the walls were *thoroughly* repaired with concrete, the lock-gates were rehung, slide-

valves placed in the lower gate, both miter sills were rebuilt, and two mud-sluices were placed behind each gate. These mud-sluices are a new device, specially designed to obviate the nuisance of mud behind lock-gates, which has been a fruitful source of trouble on this river.

A dredge-boat, specially designed for service on the Muskingum, is nearly completed.

As the Ohio River funds were low, by authority of the Chief of Engineers, the Ohio River dredges were transferred to the Muskingum, where they did most excellent service, which is reported in detail by Lieutenant Beach and Mr. Carpenter.

They dredged out the upper and lower entrances to Lock No. 2 (Devols), the lower entrance to Lock No. 3 (Lowell), the upper and lower entrances to Lock No. 8 (Stockport), and the heads of the canals at Lowell, Beverly, and McConnellsville. They dug channels through Bear Creek Bar, the bar below Lock No. 5, Stone's Ripple, and Blue Rock Bar, and wholly removed Stump Island, a most dangerous obstruction in midriver. They also took out a number of snags, old piles, and pieces of broken dam. River men state that navigation would have been stopped in April, but for this work of the dredges.

In accordance with orders from the Secretary of War a special report on the Muskingum River was made, dated December 24, 1877. I would refer to that report for many details that need not be reported here.

The special work most needed at present on the Muskingum River is the repair of the locks at Stockport (No. 6); the construction of a new lock at Taylorsville (No. 9), and the abandonment of the Taylorsville Canal; the suppression of one chamber in the combined lock at Zanesville (No. 10), and the construction of a new lock and dam at Symmes Creek (No. 11), so as to restore the Muskingum River navigation with the Ohio Canal at Dresden, and thus re-open the through water-line to Lake Erie at Cleveland.

There being no line of levels on the Muskingum River, and no means of verifying the heights of the various miter-sills, a leveling party has been employed to go over the river and secure these indispensable data.

The detailed expenditures during the past fiscal year have been as follows:

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River for the fiscal year ending June 30, 1883. General administration.

Month.	Salaries.		Surveys.	Plant.			Buildings.	Supplies.	Transportation.	Miscellaneous.	Total.
	Office force.	Lock-keepers, bridge-tenders, and watchmen.		First cost.	Repairs.	Hire.					
July	$210.00	$540.00	$342.18	$134.42	$83.96	.....	$721	70.65	$9.00	$164.23	$1,561.65
August	485.57	540.00	75.00	147.01	147.23	.....	.....	19.65	.....	210.13	1,624.59
September	370.00	540.00	115.60	1,370.03	141.38	.....	.....	44.47	1.50	252.78	2,835.76
October	392.09	492.33	181.60	773.37	63.92	$18.50	8474.74	193.31	2.56	212.60	2,805.02
November	375.00	540.00	3.40	120.33	125.61	75.00	10.07	116.69	.50	191.70	1,558.30
December	255.00	540.00	158.20	8.50	22.95	.....	.....	22.84	.50	226.64	1,234.63
January	488.34	540.00	10.40	39.35	7.85	.....	.....	36.25	3.35	153.53	1,279.07
February	571.67	535.00	3.10	284.32	.....	.....	7.60	19.20	.....	128.55	1,549.44
March	365.00	535.00	71.25	10.00	15.05	.....	245.05	28.80	.50	412.41	1,683.06
April	330.00	549.00	338.02	9,547.54	14.14	14.00	1,034.00	52.24	.....	173.00	12,051.94
May	330.00	555.00	815.75	1,654.05	31.39	.....	35.05	9.08	1.76	101.68	3,033.76
June	395.00	555.00	241.10	3,570.88	279.55	5.00	156.21	25.71	4.00	97.14	5,329.59
Total	4,567.67	6,461.33	1,855.60	17,659.80	933.03	112.50	1,969.93	638.89	23.67	2,324.39	36,546.81

United States dredges Ohio and Oswego.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Hire of tow-boat.	To
November	$345.00	.....	$22.65	.....	$320.00	$
December	1,203.83	$298.50	25.11	.....	1,080.00	2,
January	1,170.60	.....	43.56	$781.80	1,040.00	3,
February	1,172.77	47.45	.....	.....	765.00	1,
March	972.45	32.50	58.05	148.92	780.00	1,
April	1,159.60	.....	7.42	79.22	750.00	1,
May	1,176.50	.....	5.00	.....	840.00	2,
June	757.32	.....	80.21	53.25	300.00	1,
Total	7,958.07	378.45	242.00	1,063.19	5,875.00	15,

Steamer Vega.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	To
July	$288.07	$33.12	$49.68	$11.70	$
August	315.05	38.39	53.18	20.60	
September	312.90	72.47	23.78	20.01	
October	301.00	20.45	17.48	46.11	
November	296.50	46.05	33.50	1.26	
December	272.45	.....	39.89	188.55	
January	60.00	.....	.25	171.42	
February	60.00	45.75	.....	274.98	
March	178.01	46.41	14.77	115.94	
April	325.50	25.81	19.38	4.05	
May	354.00	.....	15.82	10.05	
June	362.75	4.25	.....	1.32	
Total	3,126.23	332.70	267.73	865.99	4,

Repairs of locks and dams.

NO. 1.—MARIETTA AND HARMAR.

Month.	Labor.	Material.	Boat-hire.	To
July	$601.87	$23.63	$4.25	$
August	329.74	248.46	.70	
September	2,173.63	3,766.01	16.05	5,
October	1,771.46	2,585.13	48.61	4,
November	33.22	729.27	.....	
December	95.73	1,358.87	.....	1,
January	269.26	8.50	.....	
March	12.46	.....	.....	
April	.....	78.34	.....	
May	513.25	149.43	.....	
June	1,120.46	1,132.21	.....	2,
Total	6,921.02	10,079.85	69.61	17,

NO. 2.—DEVOL'S.

July	1,019.83	121.72	116.75	1,
August	2,747.76	601.07	122.50	3,
September	2,193.57	8,779.12	75.00	11,
October	2,153.06	399.42	23.25	2,
November	664.89	1,433.40	219.25	2,
December	.....	1,084.25	.....	1,
February	2.18	.....	.....	
April	4.06	87.05	.....	
May	.....	166.03	.....	
June	.....	1,257.70	.....	1,
Total	8,785.35	14,529.76	556.75	23,

Repairs of locks and dams—Continued.

No. 3.—LOWELL.

Month.	Labor.	Material.	Boat-hire.	Total.
July	$102.35	$7.35	$240.00	$349.70
August	88.50	3.15	.....	91.65
September	770.26	29.06	.....	799.32
October	889.29	1,220.79	.....	2,110.08
November	271.43	1,123.85	.....	1,395.28
December	17.24	1.08	.....	18.32
January	.40	.....	.....	.40
February	19.80	.....	.....	19.80
March	65.68	.....	.....	65.68
April	24.60	8.70	.....	33.30
May	37.08	16.60	.....	53.68
June	5.88	125.77	.....	131.65
Total	2,292.51	2,536.35	240.00	5,068.86

No. 4.—BEVERLY.

July	113.90	257.24	.....	371.14
August	145.90	.....	10.66	156.56
September	303.30	706.90	.....	1,010.20
October	1,103.69	669.99	2.22	1,775.90
November	2,736.51	1,549.87	30.27	4,316.65
December	242.67	2,513.55	.....	2,756.22
January	424.26	.....	.....	424.26
February	14.04	.....	.....	14.04
April	282.22	469.53	.....	751.75
May	526.41	91.27	.....	617.68
June	767.62	3,507.66	.....	4,275.28
Total	6,660.52	9,766.01	43.15	16,469.68

No. 5.—LUKE CHUTE.

July	1,392.55	1,215.03	504.00	3,111.58
August	1,586.06	1,868.96	160.00	3,615.02
September	2,281.10	2,985.21	3.50	5,269.81
October	3,191.04	4,262.95	8.50	7,462.49
November	813.21	2,276.84	7.50	3,097.55
December	.....	2,146.68	.....	2,146.68
January	.....	189.42	.....	189.42
February	11.06	.....	.....	11.06
May	.....	249.06	.....	249.06
June	.....	1,886.55	.....	1,886.55
Total	9,275.02	17,080.70	683.50	27,039.22

No. 6.—STOCKPORT.

July	14.00	.....	.....	14.00
August	.....	.20	.....	.20
September	312.44	25.98	.....	338.42
October	468.49	389.69	.....	858.18
November	116.30	832.84	.....	949.14
January	12.00	.....	.....	12.00
February	15.58	.....	.....	15.58
April	33.60	.....	.....	33.60
Total	972.41	1,248.71	.....	2,221.12

Repairs of locks and dams—Continued.

No. 7.—McCONNELSVILLE.

Month.	Labor.	Material.	Boat-hire.	Total.
July	$53.04	$1.24	.....	$54.28
August	133.20	3.04	.....	136.24
September	1,368.95	110.09	.....	1,479.04
October	729.69	864.70	.....	1,594.39
November	677.46	1,235.37	$10.00	1,922.83
December	127.98	452.39	.....	580.37
January	305.39	.....	.....	305.39
February	14.46	.45	.....	14.91
March	174.58	.....	.....	174.58
April	481.40	5.10	.....	486.50
May	842.76	12.27	.....	855.03
June	1,037.37	.....	.....	1,037.37
Total	5,946.28	2,684.65	10.00	8,640.93

No. 8.—EAGLEPORT.

August	32.00	.....	.....	32.00
September	702.12	477.86	38.75	1,218.73
October	1,712.04	2,613.46	72.00	4,397.50
November	571.37	2,691.77	55.00	3,318.14
December	.....	106.69	.....	106.69
January	3.08	.....	.....	3.08
February	100.88	.....	.....	100.88
March	.....	.75	.....	.75
April	2.10	.....	.....	2.10
May	20.40	.....	.....	20.40
Total	3,143.99	5,890.53	165.75	9,200.27

No. 9.—TAYLORSVILLE.

July	284.93	406.63	.....	691.56
August	535.23	584.35	.....	1,119.58
September	238.56	368.06	172.84	779.46
October	1,645.16	1,019.37	.....	2,664.53
November	2,633.20	2,058.22	.....	4,691.42
December	883.74	2,163.41	.....	3,047.15
January	85.50	.....	.....	85.50
March	23.28	200.92	.....	224.20
April	29.46	44.75	.....	74.21
May	18.15	83.00	.....	101.15
June	.....	628.85	.....	628.85
Total	6,377.21	7,557.56	172.84	14,107.61

No. 10.—ZANESVILLE.

July	67.52	80.35	.....	147.8[illegible]
August	382.65	427.30	.....	809.9[illegible]
September	441.25	1,251.35	.....	1,692.6[illegible]
October	27.34	103.90	.....	131.2[illegible]
November	194.52	1.83	.....	196.3[illegible]
December	209.26	.36	.....	209.6[illegible]
March	53.37	1.00	.....	54.3[illegible]
April	90.44	.....	.....	90.[illegible]
May	80.94	8.38	.....	89.3[illegible]
June	134.79	.38	.....	135.[illegible]
Totals	1,682.08	1,874.85	.....	3,556.[illegible]

Summary.

General administration	$36,546.81
United States dredges *Ohio* and *Oswego*	15,516.71
Steamer *Vega*	4,592.65
Lock and dam—	
No. 1	17,070.48
No. 2	23,871.86
No. 3	5,068.86
No. 4	16,409.68
Lock and dam—	
No. 5	$27,039.[illegible]
No. 6	2,231.[illegible]
No. 7	8,640.[illegible]
No. 8	9,200.[illegible]
No. 9	14,107.[illegible]
No. 10	3,556.[illegible]
Total expenses incurred	183,903.[illegible]

Estimate for 1888–'89.

Repair of—		
Dam No. 1		$5,000
Dam No. 2	$5,200	
Lock No. 2	600	
		5,800
Dam No. 3	2,500	
Lock No. 3	7,786	
		10,286
Dam No. 4	18,600	
Abutment No. 4	7,609	
Lock No. 4	6,000	
		32,209
Dam No. 5	1,000	
Lock No. 5	4,650	
		5,650
Dam No. 6	600	
Lock No. 6	21,000	
		21,600
Dam No. 7	2,500	
Lock No. 7	3,300	
		5,800
Repair of—		
Dam No. 8	$5,920	
Lock No. 8	50,350	
		$56,270
Dam No. 9		1,000
Dam No. 10	600	
Head of Canal No. 10	888	
Lock No. 10	3,300	
		4,788
Salaries of lock-keepers		6,660
Steamboat *Vega*		4,500
Dredging		10,000
Clerks and draughtsman		4,740
Rents, fuel, gas, and water		420
Surveys		1,200
Contingencies		5,000
Total		180,923

The cost of maintaining these locks and dams is borne by the indefinite appropriation for "operating and care of canals," etc., and the following money statment refers only to the specific appropriation for "improving Muskingum River, Ohio."

Money statement.

July 1, 1887, amount available	$4,896.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,896.92

Abstract of proposals for dimension stone for Muskingum River, Ohio, opened April 2, 1888.

No.	Bidders.	Per cubic yard.	Aggregate.	Remarks.
1	E. M. Ayers	$2.69	$2,690	
2	T. B. Townsend & Co	2.98	2,980	
3	Blake & Gormley	2.99	2,990	Slightly informal.
4	Williams & Toute	3.25	3,250	Do.
5	E. B. Henderson & Son	3.33	3,330	
6	Joseph Garrett and Oliver Dempster	4.15	4,150	Do.
7	Josiah T. Hart	4.40	4,400	
8	Henry Erbe	4.50	4,500	

The contract was awarded to E. M. Ayers, and was executed April 12, 1888.

Abstract of proposals for gate anchorages for Muskingum River, Ohio, opened April 2, 1888.

No.	Bidders.	Per set.	Aggregate.	Remarks.
1	The Griffith & Wedge Company	$48.00	$1,824	Slightly informal.
2	Queen City Bridge and Steam-forging Company	49.00	1,862	
3	The L. Schreiber & Sons Company	59.00	2,242	
4	The King Iron Bridge and Manufacturing Company	59.50	2,261	Do.
5	Chester B. Albree	63.00	2,394	
6	Sharron Boiler Works, Limited	65.00	2,470	Do.
7	Charles Barnes	73.50	2,793	

The contract was awarded to the Griffith & Wedge Company and was executed April 12, 1888.

6	James B[illegible]eed	R. B. & S	3.

* Slightly informal.

The contract for Portland cement was awarded to John
cuted April 24, 1888.

The contract for natural cement was awarded to James
April 12, 1888.

Abstract of proposals for hoisting engines for Muskingum

No.	Bidders.	Engine No. 1.		Engine No. 2.
		New.	Second-hand.	New.
1	W. F. Robertson & Co	$500.00	.....	$1,000.00
2	Harmer Foundry and Machine Company.	550.00	.....	.....
3	Charles Barnes	554.50	.....	1,256.25
4	The Griffith & Wedge Company	555.00	.....	1,050.00
5	J. S. Mandy	575.00	.....	1,050.00
6	Vulcan Iron Works	580.00	.....	1,190.00
7	G. S. Wormer & Sons	600.00	.....	1,225.00
8	Wm. Chisholm & Sons	600.00	$600.00	1,200.00
9	Wood Engine and Machine Company.	600.00	.....	950.00
10	S. C. Forsaith Machine Company	625.00 700.00	.....	1,125.00 1,375.00
11	Thos. Carlin's Sons	630.00	.....	1,100.00
12	Edward Kendall & Sons	650.00	.....	1,350.00
13	Copeland & Bacon	685.00	.....	1,295.00
14	James W. Soper	.....	.....	.....

The contract for Engines No. 1 and No. 2 was awarded to
pany, and was executed April 24, 1888.

The contract for Engine No. 3 was awarded to G. S. Wor
cuted April 30, 1888.

Abstract of proposals for furnishing iron drift-bolts for Mus
2, 1888.

Abstract of proposals for furnishing timber for Muskingum River, opened April 2, 1888.

No.	Bidders.	Amount bid for.	Per thousand.	Aggregate.	Remarks.
1	Joshua R. King	All	$19.00	$9,500	
2	John F. King	do	20.00	10,000	
3	Irish & Warner	do	21.23	10,615	
4	Hays Bros. & Woodruff	do	21.50	10,750	Informal.
5	J. R. Gorby	One-half	21.50	5,375	Slightly informal.
6	Marietta Chair Company	All	17.00 24.00	10,873	Undr 16 feet. Over 16 feet.
7	S. H. Stinchcomb	do	21.75	10,875	Slightly informal.
8	Patterson, Burgess & Co	do	22.00	11,450	Do.
9	W. H. Taylor	One-half	27.00	6,750	Informal.

The contract was awarded to Joshua R. King, and was executed April 12, 1888.

REPORT OF LIEUTENANT L. H. BEACH, CORPS OF ENGINEERS.

On July 1, 1887, the river had been in charge of the United States less than three months, during which time high water had prevented nearly all works of repair, and had permitted but little examination to ascertain the true condition at the various locks and dams. As neither maps nor any papers showing details had been received from the State of Ohio, the only information possessed was such as could be obtained from personal examination; and even where the exterior of the various structures was visible it required the experience of subsequent operations to show how defective had been the original construction, and how fatally frail everything had become through the patch-work and surface methods of repair used by the State for the last twenty years. Of the dams, 120 feet of No. 1 had been carried away by high water, also 145 feet of No. 2, and two pieces of No. 5, one 80 feet and the other 160 feet, and in all these places the water had cut channels varying from 15 to 27 feet in depth; 200 feet of dam No. 2, between the break and right abutments, was in a most dangerous condition, and 140 feet of No. 4, threatened also to give away at any moment; the other dams, while not in imminent danger, were not in condition, with the exception of No. 9, to stand through the coming winter, and all were in need of urgent repairs. Of the locks, No. 9 appeared liable to collapse, owing to the crumbled and disintegrated condition of its walls, and the others varied from a similarly dangerous condition to one of safety. In all of them the gates and their anchorages were most weak, and in many cases too infirm for safety; the valves were without exception so imperfect, through either bad construction or wear, that the leakage past them was torrential; in many cases it was so great that the Government steamer could not navigate the upper end of a pool without having the valves opened in the lock above to supply the water lost at the lock below. The canals, through long neglect, were choked with mud, while the numerous snags, combined with the low water in the river, made navigation difficult and dangerous. Of materials there was absolutely nothing, and the plant on hand, not claimed by private parties, consisted of 3 scows, 6 axes, and 2 shovels.

Surveys and examinations, the gathering of tools and materials, and the work of reconstruction, had to be prosecuted simultaneously, and this left us no time for the adoption of a definite plan to correct previous errors in regard to relative heights of dams and miter-sills, for the break in No. 1 had to be closed before timber could reach No. 2, and both this dam and No. 5 had to be repaired before material could be brought to No. 4. Miter sills could not be changed without new gates, and this under the circumstances was impossible; but as far as practicable all work done was with the view of establishing a 5-foot navigable depth of water.

For the improvements of the river Congress appropriated $20,000 in the river and harbor act of August 5, 1886, and for maintenance and repair the sum of $190,000 was allotted toward the end of July. The lateness of the season at which this latter fund became available prevented advertising and formal contracts for either materials or the work itself, and everything was in consequence done by hired labor with materials purchased in open market at the lowest prices that could be obtained.

The work first undertaken was to repair the broken dams and restore navigation as soon as possible; new structures of approved cross section were built in each of the gaps, and across the dangerous places named above.

The break in No. 1 was repaired by building a section of slope-dam on piles from the lock to the further side of the gap. It was well filled beneath with stone, and a bulkhead placed along the down-stream row of piles to prevent the rock from being washed away.

At No. 2 the dam was built in successive steps of increasing height from top to bottom, but at the other localities the down-*stream* race was made a slope of 1 on 4, with a 10-

slope dam, and also undermined on account of the press of w
portion of superstructure next the lock-wall was removed, m
little longer than the gap made by the water. The second
closed by about 160 feet of slope-dam, built, as at No. 4, upo
bottom and well filled with stone.

No. 6 received a new step of over 100 feet in length.

At No. 8, under former repairs by the State, the crest upon
further down-stream than the toe of the part on the right. A
was replaced by a slope-dam, and the crest was set back on
other end. The previous irregular form caused a tremendou
of the dam, which scoured out a hole 37 feet deep, reaching
until the whole structure began to sag and settle; this was t
crib-work on piles filled underneath and in front with large
No. 10 received a new step of over 100 feet in length.

All the dams received considerable repairs in new sheeting,
above mentioned.

Owing to high water, no repairs have yet been possible duri
The repairs to the locks were made mainly at Nos. 1, 5, 7, a

At No. 1, operations were begun in December to remove t
the land lock-wall, into which there was a leak of such mag
terfere with locking, and to seriously threaten the wall its
Ohio stopped this work early in January, and it was not pra
tions until May, but the work has now been completed, the s
with earth, the leak stopped, and the lock made secure from t
of the timber taken from this old mill-race is considerably m
work done. Owing to other causes, however, the lock can la

At No. 5, advantage was taken of the extremely low water, c
in the dam at that place, to put in a new upper miter-sill and
ber, both of which being entirely exposed, the work was do
pumping. Concrete was rammed down to bed-rock under t
between them up to the level of the floor, rendering another le
before, impossible. Several stones were cut and placed in the

At No. 7, the unsafe culvert connecting the land lock-wal
an old abandoned mill-race was removed, and the race filled
riprapped. An immense leak had existed through this wall,
far as possible by injection of cement. Half of the floor of t
was relaid with concrete, and the head of the land-wall giv
crete where it had been undermined by the leak before mentio
found, had been washed out of this wall, and it has since sh
ing, but how serious this is remains to be determined.

No. 9 was at the beginning of the season in a most defect
feet of the lower miter-sill was entirely gone, making a lea

under the miter-sill. A slide-valve, worked from the top of the lock-wall, closes the upper end. This lock is now the best on the river.

During the present season gates have been built for the head of Beverly Canal, but are not yet in position. Upper gates for Lock No. 4 are in process of construction.

Of the lateral canals, that at Lowell has given the most trouble, owing principally to the material washed in by a small stream (Cat's Creek) emptying into the canal near the upper end. It was kept open as long as possible by the use of shovels and scrapers, and afterwards by forcing a stern-wheel steamer slowly backward through the canal in a strong current caused by opening the mill-sluices, the current carrying away the mud stirred up by the wheel.

The canals at McConnellsville and Zanesville were kept navigable by having men with hoes stir up the mud which was washed out by a similar current.

In November, 1887, the Ohio River having reached a stage unfavorable for work there, the dredges *Ohio* and *Oswego* were ordered into the Muskingum, and continued at work in this stream until the fore part of June; during this time they cut away the projecting banks immediately above and below Locks No. 2, 6, and 8, deepened the heads of the canals at McConnellsville and Beverly, and the Lowell canal for half its length, cut out just below Dock No. 3, and made navigable channels through the bars at Bear Creek below No. 3, at Stone's Ripple below No. 7, at Blue Rock half-way between Nos. 8 and 9, and through the bar of bowlders below No. 5; all the stumps of decayed piles were pulled out at Locks Nos. 2, 3, 4, 6, and 8, and in the Lowell and McConnellsville canals; several pieces of dam were taken away and 228 snags were removed, not including the collection of stumps known as Stump Island, which was also removed. Mr. Carpenter's report annexed hereto gives a complete statement of the work done.

A contract was made with the Bucyrus Foundry and Manufacturing Company for a ladder-dredge, which has not yet been finished.

A surveying party was put into the field as early as practicable, and careful surveys made at each of the locks and dams; the resulting maps, together with the daily observations established at each lock, and the line of levels now being run from the Coast Survey bench-marks at Parkersburgh to Dresden, will, it is believed, give all necessary information for establishing a correct regimen for the river.

An injunction was obtained in September from the United States district court for the southern district of Ohio, restraining the Cincinnati and Muskingum Valley Railroad from further encroachments upon the river at Zanesville, as the stream was being injuriously narrowed.

The Zanesville and Ohio River Railroad, through an honest mistake as to ownership, runs without authority across Government land at Malta, but has made no effort to obtain the right of way, although the proper officials have been many times urged to do so.

The various leases for land and for water-power remain very much in the same condition as a year ago. The lease of Chase & Andrews, originally Humphries & McGrath, and the lease of A P. Stultz have been canceled, and the lease of Dircks & Bahlman authorized to be canceled on certain conditions, which have not yet been fulfilled by the lessees.

Revocable licenses were granted for land at Zanesville to W. W. Miner on August 30, and to Gary Bros. & Silvey on November 30; several applications for licenses for water-power, and to occupy tracts of land, were before the office, and in the hands of the authorities at Washington, but having granted those above mentioned the Secretary of War doubted his authority to issue such license without the sanction of Congress, and declined to take further action. Under these conditions all mills using water were allowed to continue under former rates, although in some cases the leases had expired; for to close the mills and cause their removal from Government land would have been too great a hardship, for which there was no necessity. The amounts derived from rents during the past year are given in the table at the end of this report.

The store-yard for the river has been established at McConnellsville, where the land belonging to the Government is of sufficient extent and more conveniently located for the purpose than at any other point on the river. A portion of the lot has been fenced in and two store-houses erected. A landing on the canal-bank and roads leading to it have been graded, but are not yet in a permanent condition. Much inconvenience and loss of time is experienced through lack of a carpenter and blacksmith shop, as all work of these kinds has, in rainy weather, to be suspended or carried to private parties up-town.

The Government steamer *Vega* was throughly repaired during the winter; it has been of great service in towing and handling barges and other boats about the works, but has not sufficient power to do all the work which should be done by a general-service boat.

The largest part of the work done during the present season up to date has been the collection of materials and the preparation of plant for active operations when the water in the river will be at a more favorable stage.

Do	1	Dirks & Bahlman	1,000	1
Devol's	2	Gates & Payne	1,200	1
Lowell	3	Rechateiner Bros	750	1
Do	3	F. Wilking & Co	2,000	2
Beverly	4	H. C. Baldwin	1,200	1
Do	4	Mary L. Baldwin	1,200	1
Do	4	J. D. Spooner	600	
Do	4	D. T. Brown	1,750	
Do	4	C. R. Stull		2
Stockport	6	Pierrot & Lane		2
Zanesville	10	Garey Bros. & Silvey	500	1
Do	10	Drone & Co		5
Do	10	Edward Johnson	6,100	4
Do	10	Joseph Shaw	750	1
Do	10	Beumont & Plankenbuhler	500	2
Do	10	Herdman, Harris & Co	2,200	4

Locality.	Number of dam.	Rent for six months. November 1, 1887, to April 30, 188		
		Number of days without water.	Rebate.	Amount paid.
Marietta	1	120	$127.27	$47.73
Do	1			
Devol's	2			87.50
Lowell	3			50.00
Do	3			125.00
Beverly	4	19	5.76	44.24
Do	4	19	5.76	44.24
Do	4	19	4.32	33.18
Do	4	19	3.63	27.87
Do	4	17	11.59	100.91
Stockport	6			125.00
Zanesville	10			50.00
Do	10			250.00
Do	10			200.00
Do	10			75.00
Do	10			125.00
Do	10			200.00

Land leases.

Revocable licenses.

Locality.	No. of dam.	Licensees.	Privilege.	Rent per annum.	Rent payable.	Rent paid.	License issued.
Zanesville	40	W. W. Miner	Use of land	$20.00	Jan 1	$6.67	Aug. 30, 1887.*
Do	10	Garey Bros. & Silvey	do	80.00	May 1, Nov. 1	33.33	Nov. 30, 1887.†

* From September 1 to December 31. † From December 1 to May 1.

Changes during year.

Locality.	No. of dam.	Lessees.	Privilege.	Date terminated.	Reason terminated.
McConnelsville	7	Chase Anderson	Water power		Canceled by Secretary of War upon lessee's application.
Zanesville	10	A. P. Stultz	Land		Do.
Do	10	Wm. Miner	do	July 30, 1887	Expired.
Do	10	Edward Martin	do	Aug. 3, 1887	Expired; not renewed.

Revocable licenses to W. W. Minor and to Garey Bros. & Silvey, issued during the year.

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER.

Mouth of Muskingum River.—The channel leading from the Ohio River to Lock No. 1 was widened and deepened by dredging near the shore on the Marietta side and in the entrance below the lock. Excavation made November 22–23, 1887, 2,208.6 cubic yards; June 8–12, 1888, 2,205 cubic yards. Total, 4,485.6 cubic yards. There were also removed 7 snags weighing 8.4 tons, and 3 piles.

Lock No. 3.—A mud-bar obstructing the lower entrance to this lock was removed, and a number of old piles and pile-stumps were pulled out of the canal above the lock. Excavation made November 26–30, 1887, 2,240.4 cubic yards. Number of piles pulled out, 20.

Bear Creek Bar, 1 mile below Lock No. 3.—This bar, which had several times during the past season completely blocked navigation, was improved by cutting a straight channel clear through it. Excavation made November 30 to December 7, 10,023.7 cubic yards. Logs and snags removed 6, weighing 9 tons.

Lock No. 2.—The work at this point consisted in clearing out the entrance to the lock above and below, and in removing from the channel the obstructions which filled it for nearly half a mile on the left below the lock. The projecting-banks were also cut off as much as was necessary to make an easy entrance to the lock. Excavation made: Above lock, December 8–15, 5,355 cubic yards; 2 old lock-gates, 24 tons; 14 snags and logs weighing 13.7 tons; below lock, December 8–19, 3,088.9 cubic yards; 134 logs, snags, etc., 165.4 tons; 1 rock, 24 tons; 1 old lock-gate, etc., 12 tons, and 1 section of crib-dam, 12 by 30 feet.

Head of Beverly Canal.—The shore above the head of the canal projected so far into the channel that boats had great difficulty in entering it, and during high water were exposed to great danger from the draft of water over the spill-dam. The shore-point was dredged off, and the head of the canal was deepened down to the guard-gates. Excavation made December 23 to January 5, 8,857 cubic yards; 1 rock weighing 1.7 tons; 2 logs and stumps, 3.2 tons.

Head of Lowell Canal.—The upper end of the canal was deepened by dredging out the deposit of mud which caused so much trouble during the preceding season, and the upper end of the canal was enlarged and straightened. Excavation made January 6 to February 23, 37,340.9 cubic yards; June 6, 12 pile-stumps were pulled out.

Bar below Dam No. 5.—The work at this point consisted in removing a bowlder bar and straightening and deepening the channel for a quarter of a mile below the lock. Excavation made February 29 to March 26, rock and bowlders, 5,539 cubic yards; gravel and bowlders, 8,432 cubic yards; 5 large rocks, 16.4 tons; 14 logs and snags, 26.1 tons. June 4–5, 5 snags, 28 tons.

Dam No. 6.—A channel was cut through the bar on the left below the lock for a

[illegible]s in the channel near the lock were removed. Exc
above lock; mud, 1,669 cubic yards; obstructions removed, 3
gam; 11 snags, 16.8 tons; and 1 rock, 4.5 tons.

Blue Rock Bar, 4 miles above Eagleport.—A straight cut 7
through this bar, which was frequently impassable to empty
vious season. Excavation made May 16–22, gravel, 2,728 cu

McConnelsville Canal.—The old piles at the head of this
entrance deepened as far down as the spoil could be banked,
the canal for the proposed store-yard landing. Excavation
23–25, mud, 3,318 cubic yards; 44 piles, 2 wrecks of boats, and

Point 4 miles below Lock No. 7.—May 26, 2 snags, 8.8 tons.

Silver Heels Ripple, one-half mile below Stockport.—June 1, sec
15 feet by 16 feet.

Stump Island, 1 mile above Luke Chute.—This was a bar hav
submerged stumps, forming most dangerous obstructions. E
1–4, mud, 765 cubic yards, and 37 stumps.

Olney's Run.—One snag, 1.5 tons.

Dana's Island.—One snag, 1 ton.

Gravel Bank, one-half mile below Dam No. 3.—One snag, 13.5 t

Detailed statement of the amount and cost of dredging on the Muskingum River, Ohio.

Date.	Miles above Marietta, Ohio.	Locality.	Kind of work.	Days of work.	Excavation.			Rocks, snags, and other obstructions.		Expenditures.		
					Quantity.	Per day of work.	Cost per cubic yard.	Number.	Weight.	Dredging.	Removing obstructions.	Total.
					Cu. yds.	*Cu. yds.*			*Tons.*			
November, 1887, and June, 1888.	0	Mouth of Muskingum	Dredging and removing obstructions.	3	4,485.6	2,242.8	$0.056	10	8.4	$250.27	$125.13	$375.40
November, 1887	12	Lock No. 2	do	3	2,240.4	1,120.2	.112	20	10	250.27	125.13	375.40
November and December, 1887.	11	Bear Creek Bar	do	7	10,022.7	1,543.5	.081	6	9	813.36	62.58	875.94
December, 1887	5	Above Lock No. 2	do	3½	5,255	2,142	.058	16	37.7	312.84	125.13	437.97
Do	5	Below Lock No. 2	do	4½	3,088.9	3,088.9	.040	187	179.8	125.13	437.96	563.09
December, 1887, and January, 1888.	23½	Head Beverly Canal	do	4½	8,857	2,214.2	.057	4	4.9	500.54	31.29	531.83
January and February, 1888	13	Head Lowell Canal	do	34¼	37,340.9	1,098.2	.114	12	6	4,254.58	31.29	4,285.87
February and March, 1888	32½	Bar below Dam No. 5	Dredging rock and bowlders	7	5,539	791.3	.164	5	16.4	875.94	.....	875.94
March, 1888	32½	do	Dredging bowlders and gravel	9½	8,432	1,204.6	.104	19	55.1	875.94	312.84	1,188.78
April and May, 1888	37½	Bar below Dam No. 6	Dredging and removing obstructions.	3	7,463.5	2,487.8	.05	2	1	375.40	.....	375.40
May, 1888	38	Bar above Dam No. 6	do	1½	2,195	4,390	.029	36	18	62.57	125.13	187.70
April and May, 1888	47½	Stone's Ripple	do	29	40,553	1,502	.084	21	11.8	3,378.64	250.27	3,628.91
May, 1888	55	Above Lock No. 8	do	1	1,669	3,338	.038	.....	.....	62.57	62.57	125.14
Do	55	Below Lock No. 8	do	3	5,880	3,352	.053	57	43.8	312.84	62.57	375.41
Do	59	Blue Rock Bar	Dredging	5	9,728	1,945.6	.064	.....	.....	625.68	.....	625.68
Do	48	McConnelsville	Dredging and removing obstructions.	2½	3,318	2,654.4	.047	58	42.4	156.42	156.42	312.84
Do	44		Removing snags	½	.....	.....	.....	2	8.8	.....	31.29	31.29
June, 1888	37	Silver Heels Ripple	Removing old crib-dam	½	.....	.....	.....	2	10	.....	31.28	31.28
Do	33½	Stump's Island	Dredging and removing stumps	2	765	3,060	.041	37	19	31.29	218.99	250.28
Do	28	Olney's Run	Removing snags	½	.....	.....	.....	1	1.5	.....	15.64	15.64
Do	20	Dana's Island	do	½	.....	.....	.....	1	1	.....	15.64	15.64
Do	11½	Gravel Bank	do	½	.....	.....	.....	1	13.5	.....	31.28	31.28
				124	156,934	1,471.1	.....	.....	.....	13,264.28	2,252.43	15,516.71

MUSKINGUM RIVER DREDGING, 1887-'88.

Time.

	Days.
Time at work:	
Dredging	106
Removing snags, rocks, and other obstructions	18
	124

	Da
Time lost:	
Traveling	
High water, ice, etc	
Accidents and laying up fleet	
Sundays and holidays	
Total number of days	

Work.

Excavation per day of work...cub. yds..	1,488
Total excavation.....do....	156,934
29 large rocks removed.....tons weight..	36.8
249 logs and snags removed.....do....	335.9

11 sections of old crib-dams removed.
2 wrecks removed.
3 old lock-gates removed.
153 piles pulled out, removed.

Cost.

Equipment:		
Per day in commission	$1.86	
Per day of work	3.05	
Total		$378.45
Towing:		
Per day in commission	28.79	
Per day of work	47.38	
Total		5,875.00
Repairs:		
Per day in commission	6.39	
Per day of work	10.52	
Total		1,305.19

Salaries:		
Per day in commission	$39.62	
Per day of work	64.18	
Total		$7,958
Total expenses:		
Per day in commission	76.06	
Per day of work	125.12	
Total		15,516

Cost of work, including all expenses.

Dredging	$13,264.28
Removing rocks, logs, and other obstructions	2,252.43

Per cubic yard of excavation	$0.
Per day in commission	76.
Per day of work	125.

Commerce of Muskingum River during part of fiscal year ending June 30, 1888.

Month.	Lock No. 1.					Lock No. 2.				
	Steamboats.	Barges.	Miscellaneous.	Total.	No. of lockages.	Steamboats.	Barges.	Miscellaneous.	Total.	No. loc ag
March	67	18	1	86	86	110	18	5	133	
April	58	10	50	118	111	74	44	21	139	
May	63	14	32	109	109	87	17	13	117	
June	42	29	22	93	92	61	16	10	87	
Total	230	71	105	406	398	332	95	49	476	

	Lock No. 3.					Lock No. 4.				
March	106	14	3	123	123	56	6	1	63	
April	113	16	7	136	135	73	7	3	83	
May	77	22	4	103	103	68	13	2	84	
June	63	11	2	76	75	60	18	2	80	
Total	359	63	16	438	436	257	44	9	310	

	Lock No. 5.					Lock No. 6.				
March	55	7	2	64	63	52	1	.....	53	
April	62	10	1	73	71	65	13	5	83	
May	66	14	1	81	72	61	17	3	81	
June	61	16	3	80	71	60	13	5	78	
Total	244	47	7	298	276	238	44	13	295	

Commerce of Muskingum River, etc.—Continued.

	Lock No. 7.					Lock No. 8.				
March	57	5	1	63	62	106	13	.....	119	112
April	61	4	4	69	62	112	19	.....	131	118
May	64	43	9	121	104	116	30	9	155	149
June	62	12	5	79	74	111	17	6	134	121
Total	244	63	19	332	307	445	79	15	539	500

	Lock No. 9.					Lock No. 10.				
March	106	5	.....	112	111	104	2	3	109	106
April	112	16	3	125	117	111	.....	3	114	111
May	115	26	1	141	126	111	6	2	119	114
June	113	12	7	133	125	109	6	.....	115	111
Total	448	53	11	512	479	435	14	8	457	442

SUMMARY.

	Steamboats.	Barges.	Miscellaneous.	Total.	No. of lockages.
Lock No. 1	230	71	105	406	398
Lock No. 2	232	95	49	476	475
Lock No. 3	359	63	16	438	436
Lock No. 4	257	44	9	310	300
Lock No. 5	244	47	7	298	276
Lock No. 6	238	44	13	295	295
Lock No. 7	244	69	19	332	307
Lock No. 8	445	79	15	539	500
Lock No. 9	448	53	11	512	479
Lock No. 10	435	14	8	457	442
Total	3,232	579	252	4,063	3,908

There was no through navigation on the Muskingum from July 1, 1887, to the end of February, 1888, on account of necessary repairs to locks and dams in the summer and autumn and stoppage by ice in the winter.

Table showing amount of principal items of freight and the number of passengers carried on Muskingum River between March 1 and June 30, 1888.

Articles transported.	Amount.	Articles transported.	Amount.
[illegible]ick ..... number	45,500	Iron ..... tons	90
[illegible]ttle ..... do	280	Lumber ..... feet B. M.	1,625,169
[illegible]ssified freight ..... pounds	9,107,400	Oil ..... barrels	916
[illegible]al ..... bushels	29,400	Potatoes ..... bushels	3,440
[illegible]rn ..... do	4,500	Salt ..... barrels	1,790
[illegible]gs ..... dozen	72,100	Sheep ..... number	110
[illegible]our ..... barrels	2,490	Slate ..... pounds	176,450
[illegible]ogs ..... number	536	Straw ..... do	20,000
[illegible]ries ..... do	138	Wool ..... do	31,716
[illegible]ides ..... pounds	130,000	Wheat ..... bushels	14,658
[illegible]y ..... do	95,000	Passengers ..... number	7,745

SPECIAL REPORT REGARDING THE MUSKINGUM RIVER.

WAR DEPARTMENT,
Washington City, January 18, 1888.

The Secretary of War has the honor to transmit to the House of Representatives a report from the Chief of Engineers in regard to the Muskingum River improvement in the *State of Ohio.*

As it also appeared that further repairs would be
ing in some cases to reconstruction of the works, the
was directed to prepare an estimate of the total amou
the works in a proper condition. It appears from tl
that $268,218, in addition to the $190,000 allotted fo
will be necessary to complete the work of repair now

In order to place this matter on record, I submit
reports, to which attention is invited. The action
regard to the works on the Muskingum is found ne
requirements of section 4 river and harbor act appr

The reports submitted show that the cost of put
repair and operating them for one year will be $458,
gress has made no special provision, and which under
be paid from the indefinite appropriation referred to
keeping in repair improvements to navigation own
States.

The Secretary of War having no other funds unde
able for this purpose, has drawn on the indefinite
stated; but there is some question whether a work
ing in this case to reconstruction of particular wo
provided for by special appropriation.

WILLIAM C.
S

The SPEAKER OF THE HOUSE OF REPRESENTA

LETTER OF THE CHIEF OF ENGINE

OFFICE OF THE CHIEF OF EN
UNITED ST
Washington, D. C.,

SIR: To comply with your instructions of July 21
be prepared for transmission to Congress, at an earl
session, of the entire cost of the complete repairs im
the locks and dams on the Muskingum River I have

Commerce of Muskingum River, etc.—Continued.

	Lock No. 7.					Lock No. 8.				
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Table showing amount of principal items of freight and the number of passengers carried on Muskingum River between March 1 *and June* 30, 1888.

Articles transported.		Amount.	Articles transported.		Amount.
Brick	number	45,500	Iron	tons	60
Cattle	do	280	Lumber	feet B. M.	1,625,169
Classified freight	pounds	9,107,400	Oil	barrels	916
Coal	bushels	29,400	Potatoes	bushels	3,440
Corn	do	4,500	Salt	barrels	1,790
Eggs	dozen	72,100	Sheep	number	110
Flour	barrels	2,490	Slate	pounds	176,450
Hogs	number	536	Straw	do	20,000
Horses	do	138	Wool	do	31,716
Hides	pounds	130,000	Wheat	bushels	14,658
Hay	do	95,000	Passengers	number	7,745

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WILLIAM

The SPEAKER OF THE HOUSE OF REPRESEN

LETTER OF THE CHIEF OF ENGIN

OFFICE OF THE CHIEF OF E
UNITED S
Washington, D. C.,

SIR: To comply with your instructions of July 2
be prepared for transmission to Congress, at an ea
session, of the entire cost of the complete repairs in

Made June, 1887. unde

Lt. Col. W. E. Merrill,

1st Lieut.

by

1st Lieut. O. E. G

Corps of Engi

ville, by which the cost of its maintenance will be saved and e required for the passage of boats greatly reduced, a change pears to be judicious and desirable in the interest of navigation. e is transmitted herewith a map of Muskingum River at Lock am No. 9, showing the lateral canal at Taylorsville; and also of nineteen photograph views of the condition of several works river in July, 1887, when the United States assumed control, other set of twenty-two views of the condition in September, r, and November, 1887, when repairs had been partially made. Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

WM. C. ENDICOTT,
Secretary of War.

T OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF ENGINEERS, OF DECEMBER 24, 1887.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, December 24, 1887.

In accordance with your indorsement of July 26, 1887, on my f June 25, 1887, in which I am required to submit an estimate of t of completing the repairs of the locks and dams on the Muskin- iver, which estimate I was authorized by your letter of Septem- 1887, to postpone until December, I have the honor to submit lowing.

ould be premised that the intimate knowledge of the locks and n the Muskingum River, acquired during the present season of ntinued low water, has enabled me to present a much fuller and ccurate estimate of the cost of the necessary repairs than it would een possible to make at an earlier date, since many serious de- ave been discovered in portions of the work previously supposed a good condition. It is believed, however, that our information complete, and that no unexpected addition to the sum herein ted will be required. It should be stated that during the year half that elapsed between my examination of the Muskingum nd the date upon which it was transferred to the United States, te of Ohio did as little work as possible on the river, which ac- for the fact that navigation was stopped when the United States ossession, two of the dams being broken, and that two other occurred within a month from this time.

LOCK AND DAM NO. 1.—MARIETTA.

lock is the worst that I have ever seen, but it has been in its t dangerous condition for many years, and it will probably last e ice-harbor lock on the other side of the river is completed. It be a waste of money to repair it.

r the dam will require $18,500

LOCK AND DAM NO. 2.—DEVOLS.

ing repair of dam	$5,200	
f lock	8,250	
		13,450

LOCK AND DAM NO. 3.—LOWELL.

Repair of dam	$2,500	
Extension of right abutment	1,064	
Extension of left abutment	850	
Repair of lock	13,786	
		$1

LOCK AND DAM NO. 4.—BEVERLY.

Repair of dam	18,600	
Reconstruction of right abutment	7,609	
Guiding-crib at head of canal	2,000	
New guard-gates	1,650	
Repair of lock	9,570	
		:

LOCK AND DAM NO. 5.—LUKE CHUTE.

Completing repair of dam	6,000	
Masonry abutment	8,500	
Repair of lock	4,650	
		:

LOCK AND DAM NO. 6.—STOCKPORT.

Repair of dam	600	
Guiding-crib at head of lock	1,550	
Repair of lock	44,650	
		4

LOCK AND DAM NO. 7.—M^cCONNELSVILLE.

Repair of dam	5,753	
Guiding-crib at head of canal	900	
New guard-gates	1,650	
Repair of lock	35,150	
		4

LOCK AND DAM NO. 8.—EAGLEPORT.

Repair of dam	11,000	
Masonry abutment	7,000	
Guiding-cribs at lock	2,350	
Rebuilding of lock	87,000	
		10

LOCK AND DAM NO. 9.—TAYLORSVILLE.

Repair of dam		

LOCK AND DAM NO. 10.—ZANESVILLE.

Repair of dam	600	
New guard-gates	1,650	
Wall at head of canal	888	
Repair of locks	7,650	
		1
Total		31
Funds now available		5
Additional funds required		26

In regard to the foregoing estimate it is necessary to explain th portion of the walls of the locks at Stockport and McConnelsville n be taken down and rebuilt, as the lime mortar with which they v originally constructed has washed out, and the walls are sprung liable to fall down at any moment.

At Eagleport Lock, which is built on gravel, the foundations l *failed* and the entire lock must be rebuilt.

The reconstruction of this lock is also necessary for the additi *reason that*, by some mistake, it was originally built 2 feet narro

than any other lock on the river. The great cost of this work is due to the difficulty and expense of securing a reliable foundation at a place where bed-rock is wholly out of reach.

The abutments of most of the dams on the river are built of masonry, but those at Lake Chute and at Eagleport are of crib-work, and are now badly decayed and need immediate replacement by something durable. Several of the existing masonry abutments are too short, and must be lengthened.

For further details reference is made to the annexed report of Lieut. Lansing H. Beach, Corps of Engineers, who is in local charge of the Muskingum River.

CHANGES RECOMMENDED.

In the foregoing estimate I have limited myself to giving the cost of putting in condition the existing slackwater between Marietta and Zanesville, making no mention of the lock and dam at Symmes Creek (No. 11), which should be rebuilt at an early day, nor of certain very desirable changes which would greatly increase the efficiency of the existing slackwater.

The Symmes Creek Dam, 10 miles above Zanesville and 6 miles below Dresden, is the upper one of the Muskingum system, and it connects this system with the Ohio Canal at Dresden. This canal runs from Portsmouth, on the Ohio River, to Cleveland, on Lake Erie, and the restoration of the Dresden connection with the Muskingum would give a second water line from Lake Erie to the Ohio River at Marietta. For the present, however, I think that the restoration of Lock and Dam No. 11 should be left out of consideration until the river below Zanesville is put in good order.

The greatest obstruction to successful navigation on the Muskingum is caused by the lateral canals; they are expensive to keep up on account of the guard-gates, the numerous draw-bridges, and the necessity of periodical dredging. Even when in perfect condition they must be navigated slowly, and it is with difficulty that boats can pass each other. There are five lateral canals on this river, of which four must undoubtedly be retained; but the fifth, that at Taylorsville, which is the longest, the most difficult and expensive to keep open, and the most liable to damage in times of flood, is wholly unnecessary, and can be abandoned by the simple expedient of building a lock at one end of the dam. The cost of maintaining a little more than a mile of useless canal would thus be saved, and the time required for passing would be appreciably reduced, while the cost of repairing flood damages would be wholly obviated. (The river has thrice carried away the canal banks and necessitated heavy expenditures for reconstruction.)

No vested interest would suffer from the proposed change, while the town of Duncan's Falls would be made accessible from below at all stages of water, and would thus be a decided gainer. The cost of the new lock, with the necessary land, is estimated at $90,000; the bottom is rock, and there is no difficulty in building a first-class lock at moderate expense.

At Zanesville there is a flight of two locks to overcome a lift of 17 feet 2 inches, for which one lock would suffice, to the great benefit of navigation. This is a very desirable improvement, and I would strongly urge that it be made. The estimated cost is $12,000.

SUMMARY.

To sum up: The cost of putting the ten locks and dams between Marietta and Zanesville *in good condition* will require, in addition to

what is now on hand, the sum of $268,218. To get rid of the Taylorsville Canal and of one lock-chamber at Zanesville will cost $102,000.

Accompanying this report is a map of the Taylorsville Canal, and two sets of photographs (41 in number) taken by Mr. E. J. Carpenter, assistant engineer, showing the condition of the locks and dams soon after the United States took possession and after the work of repair had been partly completed.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

ZANESVILLE, OHIO, *December* 16, 1887.

SIR: I have to submit the following estimate of work necessary to place the Muskingum River in proper navigable condition, together with an estimate for certain improvements which should be made in the interest of navigation, but which are not at present urgently demanded, although their necessity is a question of very short time.

The repairs demanding immediate attention, and which should be made as soon as possible, are at each lock and dam as follows:

LOCK AND DAM NO. 1.

This lock is in a most dangerous condition, and appears hardly safe for the passage of boats, but it will be impossible to remedy the defects without rebuilding it from the foundation, although, as it is expected that the Marietta Ice Harbor lock will be completed before a new one on the site of the present ruin would be available, no money is asked for its reconstruction.

Repair of old break in dam, 160 *feet* ($10,198).—This portion broke some years ago, and has never been thoroughly repaired. The State of Ohio built a brush and stone dam across the gap, but did not put in any permanent work; the danger finally became so great, that in the fall of 1886, although the Muskingum River had not yet been transferred from the State of Ohio to the United States, the General Government expended about $1,400 to temporarily strengthen this part on account of the danger to the partly constructed Marietta Ice Harbor. This section should be placed in a secure condition at once; and the only feasible plan is to build a new dam for the above distance.

Repair of dam ($8,400).—The part between the new slope-dam built, during the season of 1887, and that for which the above estimate is made, is badly out of repair, and the most economical way to place it in proper condition is to remove the present sheeting and breast-walls, which are thoroughly decayed, and replace them by a new superstructure similar to that on either side. To place sound timbers upon too weak a substructure, and do no more than to conceal the lack of strength, would only be following the method used by the State of Ohio in making its repairs, and which is mainly the cause of the present condition of the locks and dams on the river.

LOCK AND DAM NO. 2.

Completing repair of dam, 130 *feet* ($5,200).—The work of the past season was carried from the right abutment to within 130 feet of the lock-wall; and for the proper protection of the dam it should be continued, so as to replace, as soon as possible, the present weak structure now occupying this distance. For the reasons above stated any less thorough repairs than those estimated as requiring the above sum would be poor economy.

Repair of lock-walls ($600).—The walls have become quite hollow through the washing out of the lime mortar with which they were originally built, until now the mill-race adjoining the land-wall fills and empties with the lock-chamber by the water passing freely from one side to the other. The river-wall is in somewhat better condition. To repair both sides by injection and replace a few of the more disintegrated stones will, it is hoped, render the walls sufficiently strong and solid.

Repair of miter-sill ($6,000).—These sills, like most of the others along the river, are insecure and leak very badly; they should be replaced by new work substantially

constructed, and should also be provided with mud-sluices, to prevent continued deposits of mud from obstructing the gates, as is now the case. The upper miter-sill is at present below the level of the lower pool and should be raised.

One pair of new gates ($1,650).—Owing to the leaks that have existed at every lock, and the former habit of starting to open the gates before the pressure was off the upper side, nearly every lock on the river has one or both pair of gates so badly twisted and distorted, that they are almost unserviceable even when not so badly decayed as to make them dangerous from weakness, as is the case with many. This opening of the gates before the head of water is off the upper side is at several points a necessity in spite of its bad effects, because the leak through the valves in the other gates and past the miter-sill is more than the valves in the gates which it is desired to open can discharge. At No. 9 it was necessary, until recently, to leave a portion of the plank off of the upper gates in order to fill the chamber, owing to the leak at the lower end. At No. 4 the lower gates have to be opened against a considerable head of water, as their valves can not discharge rapidly enough to remove the water leaking in at the upper end. This pulling and straining, combined with a very faulty system of bracing and an attempt to make the gates last longer than could reasonably be expected under such circumstances, has rendered a pretty thorough renewal absolutely necessary.

LOCK AND DAM NO. 3.

Repair of dam ($2,500).—This amount will be required to build a crib in place of about 200 feet of the lowest apron, which has been coming up, and which will probably be gone by next spring, and for new sheeting and other timbers at some of the weaker points of the dam.

Extending left abutment of dam ($856).—This abutment, although well constructed, is of insufficient length, not extending down-stream as far as the toe of the dam, and there is consequently danger of the waters washing around behind and undermining it. An extension of the present masonry wall about 40 feet farther down-stream will, it is believed, afford due protection.

Extending right abutment of dam ($1,064).—The same conditions exist here as at the left abutment, and there is the same necessity for its extension.

Repair of miter-sill ($6,000).—The statement given under the similar item at Lock No. 2 explains the conditions and necessity for this expenditure. The upper sill of this lock will also have to be raised.

One pair of new gates ($1,650).—The reasons and necessity for this expenditure are detailed under the corresponding item at No. 2.

Rebuilding lower buttress of river-wall of lock ($4,040).—This buttress has become so broken and disintegrated that the only repair possible is to remove the present stone and rebuild the wall, making use of as much of the old material as possible. The State of Ohio endeavored to repair this some years ago by binding the stones together with iron straps, but their only effect will be to cause the wall to tumble *en masse* if not promptly rebuilt.

Raising lock-walls ($2,096).—The lower walls of the lock are too low, and navigation is frequently interrupted here when boats can lock at all other points. If raised a few feet, this condition of affairs will be remedied.

LOCK AND DAM NO. 4.

Repair of dam ($18,600).—This dam is the shortest upon the river, and is consequently subjected to the worst effects of the water. It has been put in a condition which it is hoped will enable it to last through the coming winter, but it should be repaired as soon as the stage of water will permit, and the dam should be lengthened about 100 feet at the right end, so that it may reach the point to which the scour below the right abutment has cut into the bank. This lengthening of the dam will reduce the fall in high water and thus lessen the pressure on the structure. The shortness of the present dam has caused a big eddy immediately below the abutment, and the depth of water at the edge of the dam is 26 feet.

Rebuilding right abutment ($7,609).—The present abutment is partly of masonry and partly of crib-work, with the two portions separated from each other by quite a gap, caused by the settling of the crib, which is on the down-stream end. This crib-work is decidedly unsafe, and should be replaced by masonry even if the dam were not extended; but on account of the great depth below the abutment, it is believed that it will cost no more to make this extension and build a new abutment than to try to repair the present structure.

Building crib at head of canal ($2,000).—The head of the canal is so close to the dam that there is often considerable danger to down boats from the strong current, which tends to sweep them past the entrance. The danger could be in a great measure avoided by the construction of a crib about 100 feet long above the left abutment,

Repair of dam ($6,000).—The portion between the new
mer, and the left abutment is very weak, and, moreover,
file, which can not but have a very serious effect upon the
end of the dam has been built. Its present shape and co
adding new pieces or wedges whenever the dam settled
foundation, the profile thus created continually increasing
and causing further settlement, until this end of the dam n
be called a series of approximations, having no coherence
With a new work of approved cross-section, which would t
the dam instead of causing a reaction at its very edge, it i
could be avoided in future, and that the dam would be in

Masonry abutment on left ($8,500).—The position of the p
trates the advantage that would be derived from throwin
at No. 4. The dam was originally over 100 feet shorter t
water cut into the sand forming the left bank the State
their abutment at the same time that their dam kept
masonry abutment, built just beyond the present timber c
right place, and, as the dam would be of proper length, t
danger at this point, as the river appears to have gained the

Repair of lower miter-sill ($3,000).—From what can be le
of this sill, it appears to have left the floor and to be hangi
position. Further remarks upon the necessity of replacing

One pair of new gates ($1,650).

LOCK AND DAM NO. 6.

Repair of dam ($600).—This sum will be required for new
two large leaks that at present exist through the dam.

Building guiding-crib at head of lock ($1,550).—The piles
protection to boats from the suction of the dam have been
this river a crib is considered as being much better suited
and one should be placed at the head of this lock as soon
afford the proper protection to boats during the next high

One pair of new gates ($1,650).

Repair of miter-sill ($6,000).—The lower sill of this loc
impossible to fill the chamber without forcing the upper
crabs, and allowing the last foot in height to fill from bet

Guiding-crib at head of canal ($900).—Although the head of this canal is not so close to the dam as at No. 4 or as at the upper end of lock No. 6, yet the angle of entrance exposes a boat to such an extent that a crib will be a necessary protection. The State of Ohio had piles driven at this point for that purpose, but of these hardly more than the stumps remain.

New guard-gates ($1,650).—These gates are as weak and dangerous as the guard-gates at No. 4, and, like those, need replacing as quickly as it is possible to do so.

One pair of new gates ($1,650).

Replacing miter-sill ($5,000).—The same remarks apply to these sills as were made about those at No. 2.

Rebuilding land-wall of lock ($28,500).—It was hoped that the work upon the wall this season would be sufficient to render it safe, but it appears to have been too hollow and too weak to gain the necessary strength by such treatment, and has recently shown more signs of bulging. Nothing now will render the wall secure except rebuilding, and this should be done without delay.

LOCK AND DAM NO. 8.

Repair of dam, 160 feet ($11,000).—About 200 feet of this dam was thoroughly repaired during the season of 1887, but the late time of the year at which the work was begun and the press of repairs at other points prevented the improvement being carried to the proposed extent. Everything was left, it is believed, in a safe condition for winter, but the repairs should be completed as soon as practicable.

Guiding-crib at head of lock ($1,550).—The circumstances here are almost identical with those at No. 6, and the same explanation tells the necessity for both guiding-cribs.

Guiding-crib at lower end of lock ($800).—The proximity of the dam to the lower end of this lock produces such a rapid and strong current that boats have great difficulty in entering from below at ordinary stages of water. There is a small crib at this place now, but it is not long enough and has settled to such an extent that it is hardly secure.

Building right abutment of stone ($7,000).—The present crib abutment is in a very dilapidated condition, and should be replaced as soon as possible by a substantial structure of stone, which will be by far the best and most economical in the end. The abutment should also be moved back about 30 feet, to place it more upon a line with the river bank above and below. The present abutment is liable to give way at any time.

Repair of miter-sills ($8,000).—These sills are both in a ruinous condition and demand repair as soon as possible, although it would be poor economy to repair them without first making the change demanded by the lock.

Rebuilding lock ($79,000).—The walls of this lock are in an unsafe condition, portions being exceedingly dangerous; but such is the general condition of the whole structure that it would not be advisable to make the needed repairs without rebuilding the lock; for, owing to the fact that it is 2 feet narrower than the other locks on the river, and that it was built on an insufficient foundation, which is now giving way, any work that may be put in without beginning at the bottom would only have to be taken out again in the course of a year or two in order to render the foundation secure, even if the foundation should uphold it for that length of time, which is very doubtful.

LOCK AND DAM NO. 9.

Repair of dam ($1,000).—This will be for new sheeting and to replace some of the weaker timbers.

LOCK AND DAM NO. 10.

Repair of dam ($600).—This amount will be needed for general repairs to the dam.

Two pairs of new gates ($3,300).—The gates at this point are no exception to the others for which estimates have been made, and should be rebuilt as soon as practicable.

Repair of miter-sills ($6,000).—The reasons for this expenditure have been given previously under similar items at other places.

Retaining-wall near head of canal ($888).—Just above the guard-gates the canal is very narrow, and this fault in construction is aggravated by the caving in of the banks; a portion of the rock upon the river side can very easily be removed to allow greater width, and if a retaining-wall were built to prevent any further crumbling of the earth the defect would be in a great measure overcome.

NECESSARY IMPROVEMENTS.

The repairs and changes which are not matters of necessity at present, but which are strongly demanded in the *interest of navigation*, are the following:

Building new lock at No. 9 ($85,000).—When the present lock was built the State of

[redacted] over in a few minutes.

Changing Lock No. 10 *from double to single lock* ($12,000).- very easily and greatly to the advantage of navigation built with a single chamber, but the walls were too weak the high gates and were consequently prolonged, and ano end, dividing the lift. The alteration to the former co time of lockage.

SUMMARY.

The items for necessary repairs aggregate for each local

No. 1	$18,598	No. 8	
No. 2	13,450	No. 9	
No. 3	18,200	No. 10	
No. 4	39,429		
No. 5	19,150	Total ne	
No. 6	46,800	gently	
No. 7	43,453		

The estimates do not include any per cent. for contingen the past season's work as far as possible, are believed to be lowance is made for the use of old material in many case so dilapidated as to require rebuilding, it has been found by demolition hardly more than pays for the cost of tearin ure. The items of building a new lock at No. 9, and alteri $97,000, without any per cent. for contingencies. It shoul about $50,000 is at present available for repairs, and will in portant items for which the estimate of $318,218 is mad

Very respectfully,

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First

Lieut. Col. WM. E. MERRILL,
Corps of Engineers.

REPORT OF LIEUTENANT-COLONEL WILLIAM E.
ENGINEERS, OF JUNE 25, 18

UNITED STATES ENG

rests. This rock is yielding rapidly, and unless the action is stopped by an apron the dam will evidently give way at some time in the near future. A part of this dam is already protected by an apron which thoroughly accomplishes the purpose of its construction.

DAVIS ISLAND DAM, OHIO RIVER.

Salaries	$7,430
Natural gas	193
Oil, rope, oars, drift-forks, etc	124
Rubber suit for diver	40
Repairs	450
Telephone	240
Water-gauge reports	70
Post-office box	8
Store-house and workshop	500
Riprap below dam	2,000
Removal of Pier 1	300
Contingencies	1,000
Total	12,355

MUSKINGUM RIVER, OHIO.

Office and general administration	$6,330
Lock force	6,480
Steamboat expenses	3,885
Repairs to lock and dam—	
No. 1	10,500
No. 2	30,000
No. 3	1,000
No. 4	10,600
No. 5	43,400
No. 6	1,700
No. 7	1,800
No. 8	11,500
No. 9	2,200
No. 10	3,600
General repairs to gates and apparatus	10,000
Dredge-boat	8,000
Contingencies, about 10 per cent	15,005
Total	166,000

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 28, 1887.

Respectfully submitted to the Secretary of War.

The within estimates of expenditures for operating and care of Lock and dam No. 9, Monongahela River, Davis Island Dam, Ohio River, and locks and dams on the Muskingum River, Ohio, for the fiscal year ending June 30, 1888, are recommended for approval.

Section 4 of the river and harbor act of July 5, 1884, makes provision by permanent indefinite appropriation for payment of actual expenses of operating and keeping in repair canals and other public works without interruption.

J. C. DUANE.
Brig. Gen., Chief of Engineers.

[redacted], showing exactly what work is p
ending June 30, 1888. A statement of the least am
fice for operating and keeping in repair the works
the Muskingum for the current year should also be

WM. C

[Third indorsement.]

OFFICE CHIEF OF ENG
U

Respectfully returned to Lieut. Col. William E. M
gineers, inviting attention to the foregoing indorsem
will be guided.

Colonel Merrill is requested to submit the detailed
by the Secretary of War at as early a day as practica

After such record as may be necessary has been m
be returned.

By command of the Acting Chief of Engineers.

Maj

[Fourth indorsement.]

UNITED STATES ENGINE
Cincinna

Respectfully returned to the Chief of Engineers.

The Muskingum River is in a state of extreme dil
part of the $166,000 mentioned within was for reb
but all of it was strictly for their repair. For full
tion is invited to the accompanying special report of
Corps of Engineers, who was in local charge

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 19, 1887.

Respectfully returned to the Secretary of War.

It will be seen by reference to the fourth indorsement and its inclosure that the better opportunity afforded for examination at low water has increased the estimate to $190,000.

It will be seen also by examination of Lieutenant Beach's report that it is not at present a question of rebuilding the old works, but "of preserving and continuing the use and navigation" of the river and works and of paying "the actual expenses of operating and keeping the works in repair."

The latter estimate, $190,000, or so much thereof as may be necessary, is recommended for approval.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Sixth indorsement.]

WAR DEPARTMENT,
July 21, 1887.

Respectfully returned to the Chief of Engineers.

The allotment of $190,000 for operating and keeping in repair the works on the Muskingum River for year ending June 30, 1888, is approved as recommended.

The cost of repairing the locks and dams on the Muskingum was reported to Congress January 22, 1886 (Ex. Doc. No. 48, House of Representatives, Forty-ninth Congress, first session), and although it was stated that $200,000 would be required, only $20,000 was appropriated by the river and harbor act approved August 5, 1886, for the year ending June 30, 1887.

The condition of these works, which are built in part of timber and are much out of repair, is such that this large sum of $190,000 appears to be absolutely necessary this year for operating and maintaining navigation therein as required by law, and the only funds available must come from the indefinite appropriation provided by section 4 of act of July 5, 1884; but the sums that must be expended in future, not merely for the repair but for the renovation and rebuilding of a large portion of these works, should be provided for by special appropriation and not be taken from the indefinite appropriation. It is, therefore, directed that special estimates be made for the consideration of Congress, and the Chief of Engineers will prepare a full report on this subject, which will include the papers herewith and an estimate of the entire cost of complete repairs to the locks and dams on the Muskingum River, to be transmitted to Congress at an early day of the next session.

WM. C. ENDICOTT,
Secretary of War.

[Seventh indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 26, 1887.

Respectfully returned to Lieut. Col. W. E. Merrill, Corps of Engineers, inviting attention to the foregoing indorsement, by which he will be guided.

UNITED STATES
Zanesvi

SIR: In reply to your letter of the 5th instant, I have to s
mate of the cost of operating and maintaining the Muskin
for the year ending June 30, 1888. I consider this "the lea
fice for operating and keeping in repair the works now com
River for the current year," as the works are all in such con
are imperative if navigation is to be kept open.

The estimates of $6,330 for office and general administratic
and $3,885 for steam-boat expenses I presume require no com
is evident.

Taking the necessary repairs to the works and considering
mates are:

FOR LOCK AND DAM NO. 1.

Coffer across break in dam ($4,000).—This item is absolutely
the break in the dam, which occurred on June 7, and lowere
above to such an extent that boats were unable to navigate t
ter the Muskingum from the Ohio, as the upper miter-sill of
above water.

Rebuilding about 100 *feet of dam* ($6,000).—It will be impra
possible to endeavor to keep the gap in the dam closed and
means of the above coffer. The depth of the coffer (22 feet) a
bottom (sand) are such that the gap will certainly not be able
alone, and this much timber work will be needed to keep na

Repairs to lock ($500).—This lock is in a most dangerous co
properly repaired without being rebuilt, but it is hoped that
machinery and gates and closing some of the worst leaks thro
kept serviceable until the lock on the opposite side of the riv
lock was built on a tree foundation on sand, and has settled
in the river-wall leaks, and some of the stones are a foot belov

Total for No. 1, $10,500.

LOCK AND DAM NO. 2.

Rebuilding dam ($28,000).—This dam broke last winter, an
pletely interrupted in consequence until the break was closed in
this break is 256 feet long and 25 feet high at one point, and a
was experienced in keeping it intact during the rise in the e
not think it will be possible to make it stand through the com
maining portion of the dam, for over 200 feet the l

LOCK AND DAM NO. 4.

Repair of dam, including coffer ($5,000).—For some distance near the east abutment all the aprons have disappeared and the dam here stands simply as a wall, and has bulged over 2 feet, so that it threatens to give way at any time. The only way to keep this part from going out will be to coffer around the dangerous portion and put in a substantial piece of timber work on the lower side.

Repair of abutments ($5,000).—The abutments of this dam have been allowed to get in such a condition that one is nothing more than a pile of rubble-stone and the other threatens to fall of itself, so that the chances of the latter's resisting the next high water are not sufficiently strong to warrant any delay in its repair. If something is not done before next season the river will probably be flowing around one or perhaps both ends of the dam.

New guard-gates ($600).—The present gates are in such condition as to be practically worthless, and also very dangerous, and as they are the protection of part of the town (Beverly) against flooding at high water, they should be rebuilt before fall.

Total for No. 4, $10,600.

LOCK AND DAM NO. 5.

Rebuilding dam, including foundation ($35,000).—This dam broke last winter, and was repaired by a coffer in May, restoring navigation, but the rise of June caused a new break 160 feet wide in another part of the dam. These two breaks have so demolished the dam that it will be necessary to rebuild it if it is desired to continue navigation past this point, and, owing to the character of the bottom, a portion of the dam will have to be built on piles.

Coffer across present break ($3,700).—This is necessary, as the water is at present so low that nothing can pass the lock, the miter-sill being some feet above water-level.

Repair of miter-sill ($200).—This sill had such a bad leak before the break in the dam lowered the water that it made the gates almost impossible to handle, and threatened to destroy the wooden miter-sill.

Extending abutment ($4,500).—There is the same danger at the abutment opposite the lock as at Dams No. 2 and No. 4, and it should be remedied as soon as possible.

Total for No. 5, $43,400.

LOCK AND DAM NO. 6.

Repair of miter-sill and floor ($700).—There is a very large leak through and under the wooden floor and lower miter-sill of the lock, which appears to be undermining the lock, and of course has a serious effect upon the gates. The exact extent of damage and danger can not be ascertained until the lock is pumped out, but it is believed to be serious.

Repair of dam ($1,000).—This amount will be necessary to place the dam in condition to resist the high water and ice during the winter.

Total for No. 6, $1,700.

LOCK AND DAM NO. 7.

Rebuilding culvert to mill-race ($800).—This culvert runs from the canal at the head of the lock-wall down-stream a short distance parallel to the land-wall of the lock, opening into a race. It is closed at the head by sliding-gates and is very useful for flushing out the canal and removing drift without passing it through the lock. The top of the culvert serves as a passage-way from the banks to the lock-wall. The side of this culvert next to the lock has fallen in and has apparently pulled out a portion of the lock-wall, for when the lock is full there is a stream of water from the lock about 5 feet wide and 2 feet deep, and as the lock-keeper reports the leak increasing, it will have to be repaired promptly or the lock will be rendered useless.

Repair of dam ($1,000).—This amount will have to be expended upon the dam to place it in a secure condition for another season.

Total for No. 7, $1,800.

LOCK AND DAM NO. 8.

Rebuilding portion of lock-wall ($12,000).—The river wall of the lock was built upon a horizontal tree foundation resting upon quicksand. The lower end of this foundation has been washed out, allowing the tail-wall to settle considerably. This wall also appears too weak to stand the thrust of the lower gates and is so badly cracked and bulged as to appear exceedingly dangerous. My first estimate for this was $4,000, but having learned the character of the foundation since then, I do not believe that the wall can be properly repaired for less than $12,000.

Repair of dam ($20,000).—This dam is built upon quicksand and the local conditions are such as to cause a tremendous eddy or whirl near the right-hand or west abutment. This eddy has washed out a hole some 40 feet deep just below the dam, and this hole extends back under the dam to such an extent that the backing has begun to fall into it. The piles on which the dam was originally built have been mostly washed loose, some have been carried away, and others are swinging by the spikes fastening them to the dam. The lower apron has begun to turn up and the back of the dam to cave in where the backing has disappeared, and unless this is all repaired before the next high water there will be a break in the dam that will cost many times the above sum to repair.

Repair and extension of abutment ($3,500).—This abutment is wooden crib-work filled with stone; the timber has become so rotten and weak that the abutment is in great danger of falling. To repair this and extend it a sufficient length to prevent the formation of the eddy that is having such a destructive effect upon the dam will require the amount estimated.

Total for No. 8, $35,500.

LOCK AND DAM NO. 9.

Repair of lock-walls ($1,000).—The stone of this dike between high and low water levels have become so disintegrated, and have crumbled away to such an extent that the upper part of both walls threatens to fall into the lock. Very prompt action will be necessary to prevent this.

Repair of miter-sill and floor ($700).—The same remarks apply for this item as for similar item at Dam No. 6, though here it is definitely known that about 3 or 4 feet of the miter-sill are entirely gone, and it is exceedingly difficult to manœuver the gates.

Repair of dam ($500).—This is necessary to replace sheeting carried away and to fill a few cribs with stone and secure several exposed places.

Total for No. 9, $2,200.

LOCK AND DAM NO. 10.

Rebuilding part of canal-wall ($200).—This is necessary to retain one side of a street running along the canal. At present the embankment is continually caving, and not only filling up the canal, but rendering travel along the street dangerous.

New guard-gates ($800).—The same reasons apply for this item as for similar item at No. 4.

New lower lock-gates ($800).—The present gates at this lock have become so weak as to be very dangerous, and should be replaced as soon as possible.

Repair of dam ($2,000).—The lower apron is entirely gone from this dam, with the exception of a few pieces of sheeting, and there are several breaks in the middle apron, as well as a couple in the top of the dam, all which will have to be repaired this season if the dam is to go through next winter without breaking.

Total for No. 10, $3,800.

General repairs to gates and apparatus ($10,000).—This item is intended to cover all the minor repairs that are needed at every point on the river, but for which a separate estimate can not be made, such as repairing broken and decayed corners of lock walls, of which there are several in a threatening condition; changing anchorages of lock-gates, as a great many are so arranged as to interfere with the operating of the gates; repairs to the manœuvering apparatus and changes to the same so as to make its manipulation easier and less dangerous than at present; repairs to valves and operating apparatus for same, as there is not a gate on the river which has its valves and apparatus in proper condition; hire of labor to clean the mud out of the lock chambers; removal of stone from lock-chambers, as one or two of the locks are almost impassable at present on this account; and all such expenses upon which the necessary condition of the locks depend.

Dredge-boat ($8,000).—This is absolutely necessary to keep navigation open during the low-water season, on account of the condition of the lateral canals at several of the dams. The canal at Taylorsville, No. 9, is at present impassable for the large boats, and the canal at No. 3 had but 1 foot of water in it recently.

All of these estimates are for the mere cost of the work, and do not include cost for plant, some of which is almost essential for certain works.

This makes the total estimate $174,995; and with contingencies, about 10 per cent, $15,005, brings it to $190,000, no part of which, in my opinion, can be omitted if it is desired to make certain that navigation will be kept open next season.

Very respectfully,

LANSING H. BEACH,
First Lieutenant of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

B B 9.

PRELIMINARY EXAMINATION WITH A VIEW TO A SURVEY OF THE OHIO RIVER NEAR THE CITY OF EVANSVILLE, INDIANA, TO DETERMINE WHAT, IF ANYTHING, WILL BE NECESSARY TO PREVENT A CHANGE OF THE CHANNEL OF THE RIVER IN FRONT OF THAT CITY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

GENERAL: I have the honor to submit the following report on the preliminary examination ordered by the river and harbor act of August 5, 1886, "for a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city."

The examination was made by Lieut. Lansing H. Beach, Corps of Engineers, and his report is submitted herewith.

I have to state that in may judgment the locality is "worthy of improvement" to the extent of justifying a careful survey, and I estimate the cost of such a survey at $2,200. The survey should cover a length of 30 miles of river and the whole surface of the peninsulas opposite Evansville, Ind., and Henderson, Ky., in order to give a basis for an intelligent discussion of the questions involved.

It is possible that the survey will develop facts which may make it unnecessary for the United States to do any work at this locality; but this can not be determined without such survey.

The necessity for this survey is due to the fact that there is an apparent possibility that the Ohio River may make a new channel across the peninsula opposite Evansville. Should such an event occur, the river commerce of Evansville would be most seriously injured, if not wholly destroyed; and the general commerce of the Ohio River would undoubtedly be embarrassed during the formation of the new channel, and this embarrassment might be permanent in case the new channel should prove an objectionable one.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

SIR: I have the honor to submit the following report on the preliminary examination for a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.

The object of this excavation was to determine whether there is or is not any danger of the river's making a cut-off through the neck of the peninsula opposite the extremity of which Evansville is situated. That it will do so, and thus leave the city several miles inland, has been feared by the citizens for some time. To enable an intelligent answer to be given in this regard requires such a knowledge of all the conditions prevailing as can be obtained only by an accurate survey. There are, apparently, sufficient grounds to justify the apprehension felt by the inhabitants of Evansville, and I have to recommend that the survey be made.

Very respectfully,

LANSING H. BEACH,
First Lieutenant of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

SURVEY OF THE OHIO RIVER, NEAR THE CITY OF EVANSVILLE, INDIANA, TO DETERMINE WHAT, IF ANYTHING, WILL BE NECESSARY TO PREVENT A CHANGE OF THE CHANNEL OF THE RIVER IN FRONT OF THAT CITY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, November 16, 1887.

SIR: The river and harbor act of August 5, 1886, contained the following item:

For a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.

The duty of making the survey having been assigned to me, I have the honor to submit the following report:

The city of Evansville is situated at the apex of a very sharp bend of the Ohio River, the peninsula opposite Evansville having a length of 6½ miles and a minimum width of 1⅓ miles. The total water-front of the peninsula is 15 miles, and its whole surface is, on an average, about 12 feet below flood level, the extreme oscillation of the river at Evansville being 47.8 feet.

For many years flood water passed over this peninsula without attracting much attention, or showing much effect on the surface; but during the high floods of recent years the surface has been considerably degraded, and a number of ravines have been excavated on the upper side of the peninsula, which gradually flatten out and become wide and shallow depressions as they reach the central line. As the soil is fertile, though very light, the crops are valuable, and pretty much the whole area has been cleared and cultivated. Whenever a flood comes of sufficient height to go over the ground the whole surface is denuded to the depth of the plowing, and each year the land is flooded at a lower gauge-reading. At the base of the peninsula there is a wide swamp known as Mound Slough. Only a very small portion of this ground has been cleared, and observation shows that in the slough the surface is gradually rising by deposits. A similar condition has been noticed in other parts of the peninsula, where ravines and gullies have been abandoned and allowed to grow up with weeds and bushes.

On the Mississippi River, where inland chutes are very common, it has been noted that the river hardly ever shows a disposition to deepen and enlarge them into a low-water channel, notwithstanding the fact that strong currents run through these chutes at high water, and that they materially shorten distances by river. They are usually the relics of old channels which have gradually been left to one side, and, as a rule, they slowly fill up by the accumulation of snags and sediment. As far as my knowledge goes, cut-offs on the Mississippi are always formed by the gradual abrasion of opposite sides of a peninsula, until the high-water current has a very steep slope over a barrier only a few hundred feet in width. In view of these facts, I am led to conclude that the danger of a cut-off through the Evansville peninsula will not be imminent until the distance across has been reduced to something in the neighborhood of a quarter of a mile, the shortest distance at present being about 1⅓ miles.

Notwithstanding this conclusion, it is evidently undesirable to take any risks in a case of such importance, and therefore I would recommend, as a measure of prudence, that steps be taken to stop any further lowering of the surface of the peninsula, leaving the question of bank protection in abeyance until the necessity for action becomes more *evident.*

The simple and natural method of accomplishing this result would be to build a levee along the axis of the peninsula, extending it to the insubmersible hills at its base. Two lines for such a levee were surveyed, and the estimated costs of the two are $305,000 and $317,000, respectively, the length being 6½ miles and the average depth of flood water 12 feet. The top of the levee has been placed at 4 feet above flood level, in order to allow for the raising of the flood-line that would follow from keeping the entire discharge within the natural banks. In the above estimates is included $15,000 for the land on which the levee is to be built. Another method, that would probably be effectual, would be to purchase a strip of ground along the line of the proposed levee, plant it thickly with trees and bushes, and let it stand as a living barrier to catch drift and sediment, and reduce the velocity of the overflow. In my judgment such a barrier would gradually restore the height of the area above it by deposits of sediment, and the owners of the farms on the peninsula could well afford to combine to dedicate and maintain such a strip of woodland. A width of 500 feet would suffice, and the area thus withdrawn from cultivation would contain about 350 acres of arable land and 50 acres of swamp, and would be worth at current rates about $30,000. While this land would probably fill up with trees and bushes without cost, it would yet be advisable to expedite matters by planting. This would cost about $40 per acre, making a total, for 300 acres, of $12,000. To protect the strip from cattle and from timber thieves, it ought to be inclosed by a wire fence, but an unbroken fence would not do, as transverse roads across the strip would be needed in order to preserve communication between the two sides of the peninsula. The road from Evansville to Henderson crosses the line of the proposed forest levee near Mound Slough, and at least four other crossings would be required. To fence both sides of these five crossings and to inclose the two ends would call for about a mile of fence, and the 6½ miles of length would call for 13 miles more, making a total of 14 miles of wire fencing. The cheapest variety of such fence, consisting of posts 16 feet apart, and four strands of barbed wire, costs $350 per mile. The total cost of the fencing will therefore be $4,900.

It is possible that in times of flood the current along the transverse roads will cut them into ravines, but this effect can be lessened by curving the lines of the roads; and, in case of necessity, the surface can be metaled or paved at small cost. It is believed that the contingency is remote, and need not be included in the present estimate.

The total estimate is therefore as follows:

Purchase of land	$30,000
Planting trees	12,000
Wire fencing	4,900
Engineering and contingencies	2,100
Total	49,000

The law requires the engineer in charge of a survey to state whether or not the locality is "worthy of improvement," and "what public necessity or convenience may be subserved thereby." In case the Ohio River should break through the peninsula opposite Evansville, it would probably have no effect on through commerce, but would very injuriously affect the commerce of Evansville, and would therefore injuriously affect almost the whole commerce of this part of the Ohio River, as no boat passes Evansville without stopping, except a few tow-boats bound for distant markets. It is therefore a public necessity that such an occurrence should be prevented. While I do not think a cut-off is

seriously threatened at this present, I still think that it would be a judicious expenditure to purchase and maintain a barrier of woodland and thicket along the axis of the peninsula.

For further details, reference is made to the annexed report of Mr. J. N. Caldwell, assistant engineer, who was in charge of the survey.

Accompanying this report is a map* of the locality and a sheet containing longitudinal and cross sections of the proposed lèvee.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF J. N. CALDWELL, ASSISTANT ENGINEER.

CINCINNATI, OHIO, *October* 22, 1887.

SIR: The river and harbor act of August 5, 1886, ordered "a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel in front of that city."

By your order of June 7, 1887, the charge of this survey was assigned to me, and I have the honor to submit the following report of work done:

Opposite Evansville, Ind., is a peninsula, formed by a bend in the river called the "horseshoe" or "Henderson bend." A survey was made of this peninsula. The general outline of this peninsula resembles that of a human foot, with the toe directed towards Evansville.

The distance from the apex of the peninsula to the high ground at the base is 35,000 feet, while the width varies from 4,800 feet to 11,600 feet. The surface is low, being entirely covered with water when the Evansville gauge shows a stage of 42 feet.

The surface soil is very light, being composed largely of sand, and is easily eroded by the water. The soil, being quite fertile, is devoted to crop raising, and most of the trees and bushes have been cleared from the land to fit it for this use. As a consequence, one passing over the peninsula encounters numerous sloughs that have been cut across it by the water. Each rise that covers the land cuts the slough deeper and wider, until at last there seems to be danger that the entire river may leave its old channel and cut through the peninsula. The question might naturally be asked, is this danger any greater now than at any time during the past twenty or thirty years? I think that it is, principally for the reason that the present owners of the land seem to look only to the present, and have used extra diligence in clearing off the trees and bushes. This is especially noticeable on the tract said to be owned by Dr. Harding. I was informed by a man who has cultivated this tract for a number of years that the former owner maintained a strip of timber along the river bank, which the present owner has almost entirely cleared away, and, as a consequence, the tract has been literally cut to pieces by the floods of the last few years, rendering it almost unfit for cultivation.

The tract south of this one, now owned by Mr. Bennett, is also very badly cut up, and it is here that there is the greatest danger of a cut-off being made, as through this tract the sloughs are most numerous and deepest, and the distance across the peninsula is short, being only 7,900 feet.

There is one important feature that I noticed particularly. Wherever the property-owners have neglected to cultivate the soil the vines, bushes, and trees have grown up rapidly, and by arresting the current at time of high water have caused deposits of soil to be made. Several sloughs, that I was informed had at one time been deep and dangerous, have since filled up to a considerable extent, because the owners have ceased to cultivate them and allowed nature to have her way. The left bank of the river is concave, and is cutting badly, so that the neck of the peninsula is being reduced in two ways.

Your orders to me were "to run a line along the axis of the peninsula from the apex to ground that was above the high water of 1884."

High water of 1884 corresponds with a height of 47.8 feet on the Evansville gauge. I first ran a line of levels from the gauge to a point opposite the apex of the peninsula. The line of levels was run up Fulton avenue for a distance of 1,923 feet. Fulton avenue is the highest street in the principal part of Evansville. Our line was then carried across the river, and run as nearly as practicable along the axis of the

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* Omitted.

peninsula. Frequent bench-marks were made. For a distance of 25,000 feet the north and south boundary line of property-owners corresponds very nearly with the axis, and I should have followed this line exactly, but in order to do so it would have been necessary to do some clearing of bushes and trees, and these are too valuable to be removed. The profile obtained is essentially the same as though the axis had been followed exactly. From a point 20,000 feet from the apex two lines were run to a swamp called "Mound Slough." One of these follows the axis, and for a distance of 4,250 feet is very close to the Henderson and Evansville road; the other is 1,525 feet farther east. After reaching the swamp I deemed it best to make a detour to reach the high ground, otherwise it would have been necessary to do a great deal of clearing; a thing which it was not desirable to do. A line was run around the peninsula, so as to determine its outline; the principal sloughs were run out and the roads and houses were located. As far as practicable the owners of the different tracts of land were ascertained, and the property lines were approximately located. I submit herewith a plan* and profile.*

The solidity of a levee 8 feet wide on top, with side slopes of 1 on 3, allowing 20 per cent. for shrinkage, if built on the axis of the peninsula, would be 1,450,687 cubic yards, and would cost, at 20 cents per cubic yard, $290,137.40. If built on the other line, with the same form and same allowance for shrinkage, the solidity would be 1,508,908 cubic yards, and would cost, at 20 cents per cubic yard, $301,781.60.

In order to build either of these levees it will be necessary to have a strip of land 35,000 feet long and 250 feet wide, so as to give the necessary width of base and to furnish barrow pits.

This tract will contain about 200 acres, which will cost, at $80 per acre, the price at which I am informed the land can be bought, $16,000. Land can probably be bought more readily along the axis than along the other line, for, as mentioned in another place, the axis corresponds with the boundary line between property-owners for a distance of 25,000 feet from the apex of the peninsula, and a man will naturally be more willing to sell a strip off of one side of a tract than through it.

The section of the water-way, at the time of high water of 1884, was 556,347 square feet. Should a levee be built, this would be reduced to 134,168 square feet.

I have been unable to obtain sufficient information in reference to the velocity of the current at the time of high water of 1884 upon which to base an estimate of the probable increase of flood height at Evansville in case a levee should be built as proposed.

I think that a good protection against the danger of a cut-off being made would be for the United States to buy a strip of land along the axis of the peninsula and plant it with trees and bushes. Such a strip, 35,000 feet long and 500 feet wide, containing about 400 acres, would cost, at $80 per acre, $32,000. This tract could be thickly planted with young trees and bushes for about $40 per acre, or $16,000 for the whole.

Very respectfully, your obedient servant,

J. N. CALDWELL,
Assistant Engineer.

To Col. W. E. MERRILL,
Corps of Engineers.

B B 10.

PRELIMINARY EXAMINATION OF BIG HOCKHOCKING RIVER, OHIO, FROM ITS MOUTH TO COOLVILLE.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

GENERAL: I have the honor to submit the following report on the preliminary examination of the "Big Hockhocking River from its mouth to Coolville," ordered by the river and harbor act of August 5, 1886.

The locality is "worthy of improvement," but no survey is required, as the preliminary examination developed all the necessary facts.

The examination was made by Lieut. Lansing H. Beach, Corps of Engineers, whose report is herewith submitted.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

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* Omitted.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE
Cincinnati, January 11,

SIR: I have the honor to submit the following report on the preliminary e tion of the Big Hockhocking River from its mouth to Coolville.

The Big Hockhocking, or Hocking, as it is more generally called, rises a miles south of east of Columbus, Ohio, and, flowing first southerly, then southe empties into the Ohio about 12 miles below Parkersburgh, W. Va., after a c about 80 miles.

The object desired is to have the overhanging trees cut down and obstruc the channel removed so that the lighter draught boats navigating the Ohio the medium and higher stages of that river, turn in and run up to Coolville, miles from the mouth of the Hocking. Coolville is a village of about 500 inhal and the center of a rich farming country, the larger part of whose produ claimed, would seek outlet by river were it possible for boats to reach tha It is not desired to render the stream navigable above Coolville, at whic there is a dam across the river furnishing water-power to a large flouring-mil not expected that any coal will be brought down from the Upper Hocking, b Pittsburgh coal will be brought by river at a much lower rate than is now a by the railroads. At present boats do occasionally run up to Coolville, on the stages in the Ohio, but this is not frequently attempted on account of the from overhanging trees and a few large rocks in the channel, but were these r it is probable that the local packets would run to Coolville regularly, and othe quite frequently.

The object desired can be effected at a very small cost, and the advantage would result to commerce will apparently more than justify the expenditure sary. The locality is worthy of improvement.

An estimate of the amount required to carry out the desired improvement made without resorting to a survey of the river.

Very respectfully,

LANSING H. BEACH,
First Lieut. of Engi

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

EXAMINATION OF THE BIG HOCKHOCKING RIVER FROM ITS M TO COOLVILLE, OHIO.

UNITED STATES ENGINEER OFFICE,
Cincinnati, November 25, 1

SIR: I have the honor to submit the following report on the nation of the "Big Hockhocking River from its mouth to Cool ordered in the river and harbor act approved August 5, 1886.

The Big Hockhocking is a small stream that empties into th about 12 miles below Parkersburgh. It is navigable for a distan miles, but only when there is good navigable water in the Ohio. town of Coolville, at the head of the navigable stretch, has a popu of about 500, and lies in a rich farming country that needs an out water. A small expenditure would remove the overhanging tre the few rocks that now make navigation hazardous, and would Ohio River boats to run up to Coolville whenever business ju such a trip. The estimated cost of doing the necessary work is and, in my judgment, the benefit to the people justifies this mo expenditure. For detailed estimates reference is made to the an report of Lieut. L. H. Beach, Corps of Engineers.

Commercial statistics of the Hockhocking were difficult to obtai can only be considered as approximate. It is reasonable, howe believe that river freights will be largely increased whenever the *gation of* the river is made comparatively safe. Such informati

this subject as I could get is contained in the accompanying letters from Hon. C. H. Grosvenor and from Captain Huntington.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

ZANESVILLE, OHIO, *November* 22, 1887.

SIR: I have to submit the following report of work necessary to render the Big Hockhocking River navigable from its mouth to Coolville, a distance of 5 miles, including an estimate of the amount of money necessary to complete the same.

To render this portion of the river safely navigable, a number of trees which are overhanging must be cut down, some snags and rocks must be removed from the channel, and a bar below the dam at the upper end of the proposed improvement will have to be dredged away.

The items of work and their cost may be named and estimated as follows:

130 trees to be trimmed, at $1.50	$195
88 trees to be removed, at $3	264
20 snags to be removed, at $3	60
800 cubic yards of rock to be removed, at 50 cents	400
9,000 cubic yards of dredging to be done, at 40 cents	3,600
	4,519
Contingencies, about 10 per cent	481
Total	5,000

It is believed that the proper expenditure of this sum will be sufficient to secure all that is desired of the proposed improvement, which is to enable the regular Ohio River boats to turn into the Big Hockhocking and run up to Coolville, when the former river is at a sufficiently high stage to allow them to make their regular trips.

But few boats have attempted this in the past few years, owing to the danger to their upper works from overhanging trees and projecting limbs, which danger is aggravated by the narrowness of the river, it being but 100 feet to 200 feet in width. The snags and rocks are comparatively few, and can all be removed without trouble during low water. The principal expense of the contemplated improvement will be in digging away a small bar in the river about 1,200 feet below the dam at Coolville, but, as far as can be ascertained, this bar is composed of fine material, and its removal will not be attended with difficulty, although the price per yard has been estimated at 40 cents to cover the cost of disposing of the soil. The bar to be removed is about 800 feet long, 100 feet wide, and requires a cut of about 3 feet in depth.

No estimate is made for tools or plant for use in removing the trees and rocks, as the prices allowed for doing the labor are considered sufficiently high to cover their cost.

Very respectfully,

LANSING H. BEACH,
First Lieutenant of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

LETTER OF HONORABLE C. H. GROSVENOR.

GALLIPOLIS, OHIO, *November* 10, 1886.

SIR: Your letter of November 5 is received. The preliminary examination of Big Hockhocking involves an examination of so much of the river as lies from Hockingport up to Coolville, a distance of 5 miles. The supposition is that by a small expenditure of money the overhanging trees may be removed, logs taken out, a small amount of dredging done, and it may be the removal of one rock called, as I recollect it, "The Old White Horse," lying about half way from Coolville to Hockingport. It is believed that with this amount of expenditure *by the* Government the small packets plying

between Parkersburgh, Pomroy, and Gallipolis may, during a good portion of the season, turn up Hocking that short distance and carry away products from a large flouring mill, now destroyed, but being rapidly rebuilt.

Very respectfully, your obedient servant,

C. H. GROSVENOR.

LANSING H. BEACH,
Lieutenant of Engineers.

LETTER OF IRA B. HUNTINGTON.

HOCKINGPORT, OHIO, *October* 31, 1887.

SIR: Yours received some time ago in regard to slackwater navigation of the Hocking River. At the present time there is shipped from Coolville, 5 miles up, 100 barrels flour per day, 200 to 300 bushels feed, and, I think, 75,000 to 100,000 bushels wheat, and about the same of corn would come out of the river yearly. General merchandise, $50,000 per year in Coolville. As to the amount of coal that would come out I can not make any estimate, but a vast amount.

Colonel, the general commerce of the Hocking Valley is immense, and would be increased to a large extent if we had the facility of water transportation. Fruit, wool, etc., is raised up the river in large quantities, also lumber, tan bark, etc. Col. C. H. Grosvenor, our Congressman, can give you an idea of what the commerce is.

Our country is all in hopes the matter will be pushed forward, and the work will be commenced. I was away from home when your letter came.

Hoping to hear from you again,

I am yours, etc.,

IRA B. HUNTINGTON.

Col. W. E. MERRILL,
Corps of Engineers.

APPENDIX C C.

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF TRADEWATER RIVER, KENTUCKY.

REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Falls of the Ohio, Louisville, Kentucky.
2. Indiana Chute, Falls of the Ohio River.
3. Operating and care of the Louisville and Portland Canal.
4. Wabash River, Indiana and Illinois.
5. White River, Indiana.
6. Improvement of Tradewater River, Kentucky.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 9, 1888.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1888.

I was assisted by First Lieut. E. J. Spencer, Corps of Engineers, U. S. Army, until August 19, 1887, and by Second Lieut. William L. Sibert, Corps of Engineers, U. S. Army, until April 17, 1888.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

C C 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

ENLARGEMENT OF UPPER PORTION OF LOUISVILLE AND PORTLAND CANAL.

This work has been carried on during the year under three contracts; two for excavation and one for building wall. None of the work has progressed as rapidly as it should, and the time of all of the contracts

has been extended. It is hoped that all of the work under conti will be completed by the 31st of December of this year.

The report of Mr. G. W. Shaw, assistant engineer, is appended : exhibits the amount of work done.

It is proposed to modify some of the details of the present pla this work, without increasing the original estimated cost. The mo cation consists in lengthening the dam extending from the new ca wall north and east, and making a part of it of masonry with a num of large openings with bear traps and the remainder of concrete, stead of crib-work, to be as shown on plan submitted to the Chie Engineers, U. S. Army, June 30, 1888.

The object of this modification is to provide means of keeping harbor clear of mud, and to properly connect this work with the posed work for improvement of the Indiana chute. It is also propo to slightly modify the shape of the enlargement of the canal below bridge to make an easier passage for boats.

ENLARGING BASIN OF CANAL.

This work, commenced in January, 1887, by the contractors, Glea & Gosnell, has progressed slowly during the year, it being found essary to make two extensions of the time for completing the w which is now August 31, 1888.

The shops and other buildings which had to be moved to make r for the enlargement of basin have all, with one exception, been pla in their new positions, and all of the shop buildings raised to conf to the new grade of the canal grounds and put in working order.

The swinging bridge over the old locks was moved so as to place pivot on the north side and give room for the slopes near the dry-d

The report of Mr. J. P. Claybrook, assistant superintendent, is pended.

The commercial statistics will be found in the report of the operati of the Louisville and Portland canal.

Money statement.

July 1, 1887, amount available		$280,92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$103,189.71	
July 1, 1888, outstanding liabilities	19,236.94	
July 1, 1888, amount covered by existing contracts	140,048.41	
		262,47
July 1, 1888, balance available		18.44
Amount appropriated by act of August 11, 1888		150,00
Amount available for fiscal year ending June 30, 1889		168,44
Amount (estimated) required for completion of existing project, including enlargement of canal basin		855,36
Amount that can be profitably expended in fiscal year ending June 30, 1890		370,00
Submitted in compliance with requirements of sections 2 of river and harbor act or 1866 and 1867.		

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 18

MAJOR: I have the honor to submit the following report of operations on imp *ing the falls of* the Ohio River at Louisville, Ky., for the fiscal year ending Jun *1888.*

The present project is the enlargement of the upper end of the Louisville and Portland Canal, which is being executed in accordance with the plans recommended by Lieut. Col. William E. Merrill, Corps of Engineers, in his annual report for 1883, with some modifications suggested in his report for 1885.

The work consists in the removal of earth, loose rock, solid rock, and an old stone wall and the construction of a new canal wall along the northern limit of the proposed enlargement. It has been carried on under four contracts, viz: With George W. Lewis, for excavation and removal of old river wall on the lower section; with John Molloy, for excavation and removal of old river wall on the middle section; with Gleason & Gosnell, for solid-rock excavation on the upper section, and with the Salem Stone and Lime Company for constructing the new canal wall.

The contracts with Lewis and Molloy were executed July 1, 1885, the work to be completed by December 31, 1886. The lower section, George W. Lewis contractor, was finished to grade November 24, 1886.

Two supplemental contracts have been executed with John Molloy, by which the date for completion has been extended to December 31, 1887, and December 31, 1888, respectively. The original contract with Gleason & Gosnell for the upper section was executed August 4, 1885, with the provision that the work was to be completed December 31, 1886. The time for completion has been twice extended, and is now December 31, 1888. The contract with the Salem Stone and Lime Company for the construction of the new canal wall was executed January 15, 1887. The time for completing the work has been extended from December 31, 1887, to October 31, 1888.

Work on the middle section, John Molloy contractor, was begun on the 20th of May, 1887, and continued until the 19th December following. The earth and loose-rock excavation and removal of old river wall have been completed, except so much of the earth as the contractor has used for a dam around the upper end of his work. About 77 per cent. of the solid-rock excavation had been completed on June 30, 1888.

On the upper section Gleason & Gosnell contractors, work was begun July 1, 1887, and continued until the 1st of December. There were no interruptions by high water and the season was a remarkably favorable one for the work. About 32 per cent. of the rock excavation has been completed to grade.

The Salem Stone and Lime Company, contractors for the new canal wall, closed work for the season, by reason of severe weather and danger of high water, on the last day of November, 1887. The foundation courses for the entire wall have been laid and about one-half of the wall completed.

The approximate quantities to be removed on the upper, middle, and lower sections and the amount of masonry in the new canal wall, were estimated as follows:

Materials.	Salem Stone and Lime Company.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	Lower section (George W. Lewis).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	.....	94,461	103,356
Solid-rock excavation	.....	110,000	46,449	37,402
Loose-rock excavation	.....	.....	1,500	500
Dry wall removed	.....	.....	4,152	5,413
New canal wall	9,000	.....	.....	.....

The following quantities of excavation had been removed from the upper, middle, and lower sections, and masonry laid in new canal wall, on June 30, 1888:

Materials.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	Lower section (George W. Lewis).	Canal wall (Salem Stone and Lime Company).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	73,085.50	86,649.13	.....
Solid-rock excavation	35,435.22	35,634.77	32,897.16	.....
Loose-rock excavation	.....	4,868.65	8,813.21	.....
Dry wall removed	.....	11,830.89	9,922.50	.....
Masonry	.....	.....	.....	5,612.86

The following shows the amount of materials excavated and masonry laid in the new canal wall during the fiscal year ending June 30, 1888:

Materials.	Upper section (Gleason & Gosnell).	Middle section (John Molloy).	Canal wall (Salem Stone and Lime Company).
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	9,185.5	.....
Solid-rock excavation	19,988.38	29,894.81	.....
Loose-rock excavation	.....	195	.....
Dry wall removed	.....	1,908.40	.....
Masonry	.....	.....	4,982.04

NOTE.—Lower section (George W. Lewis) completed.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

REPORT OF MR. J. P. CLAYBROOK, ASSISTANT SUPERINTENDENT LOUISVILLE AND PORTLAND CANAL.

UNITED STATES LOUISVILLE AND PORTLAND CANAL OFFICE,
Louisville, Ky., July 2, 1888.

SIR: On "enlarging the basin of the Louisville and Portland Canal at the head of the locks," I have the honor to report that the contractors for earth and rock excavation Messrs. Gleason & Gosnell, have, for the year ending June 30, 1888, excavated material as follows: Earth excavation, 42,549 cubic yards; rock excavation 3,234 cubic yards. The report for the year ending June 30, 1887, shows the excavation on the same work for that year to be: Earth excavation, 66,246 cubic yards; rock excavation, 341 cubic yards; total earth excavation, 108,795 cubic yards; total rock excavation, 3,575 cubic yards.

The contractors have on the work two boilers, three hoisters, twelve cars, and four carts.

During the year the blacksmith-shop, the canal warehouse, the engine and boiler house, and the iron machine-shop have been lifted to a height to correspond with the new grade of the grounds between the old locks and the new, and supported on brick pillars built on solid ground. The ground under and around the houses has been filled, and the houses fitted up for use.

The wood machine-shop (planing-mill) has been rebuilt, and the framing-shed has been moved into its final position. All the old shafting has been put in, and where rendered necessary by the changed positions of shop buildings new shafting has been purchased and put up. The shops, warehouse, framing-shed, and boiler and engine house have all been turned over to the superintendent of the canal.

A new foundation for the spider carrying the pivot and the circle of the swing bridge over the old locks has been built on the north side and the bridge moved across the locks and pivoted on the north side. After the bridge was moved it was adjusted so as much as possible, to take out the twist in the floor and the lateral bend in the trusses. Also the bottom timbers of the gallows-frames were trussed.

New approaches to the bridge on both the north and the south sides have been built.

The engineer's tool-house has not yet been moved into its final position, the contractors' boiler, engines, and hoisters being in the way.

Very respectfully, your obedient servant,

J. P. CLAYBROOK,
Assistant Superintendent.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

C C 2.

IMPROVEMENT OF THE INDIANA CHUTE, FALLS OF THE OHIO RIVER.

The work of the past season has been directed mainly to the removal of a large part of what is known as the left-hand reef, lying between the cross-dam and the railroad bridge, and repairs to cross-dam. The season was unusually favorable and a great deal of effective work was done, which resulted in widening and straightening the channel and putting the cross-dam in good condition. The project for the improvement of this channel was general in its nature, and contemplated the excavation of rock and construction of dikes as might be found necessary for the safety of navigation, efforts being directed to the making of a safe channel over the falls for use when the canal was inoperative by reason of high water.

During the past two years much attention has been given to the study of this part of the falls, with a view of increasing the usefulness of the Indiana channel, and greatly benefiting the passing commerce by making the channel navigable at a lower stage of the river. A definite project for the continuation of the work was submitted to the Chief of Engineers June 30, 1888.

The report of Assistant Engineer G. W. Shaw, under whose supervision the work of the past season was performed, is appended.

The commercial statistics will be found in that part of the report relating to the Louisville and Portland Canal.

Money statement.

July 1, 1887, amount available		$19,773.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,350.02	
July 1, 1888, outstanding liabilities	11.50	
		10,361.52
July 1, 1888, balance available		9,412.44
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		24,412.44
Amount (estimated) required for completion of existing project		115,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1888.

MAJOR: I have the honor to submit the following report of operations on Indiana Chute, Falls of the Ohio River, for the fiscal year ending June 30, 1888:

The present project has in view the removal of projecting rocks and reefs in the Indiana Chute, so as to make a channel 400 feet wide from the cross-dam to the railroad bridge. The work of previous seasons has been mainly devoted to the removal of the right-hand reef and adjacent points.

After an inspection of the channel on September 16, 1887, it was determined to devote this season to the removal of a long, irregular mass of projecting rocks on the south side of the chute, known as the left-hand reef. A barge was located at the head of the reef on September 24, on which were constructed a number of cribs, to be used as a breakwater. These cribs were lowered from the barge, filled with stone, and sheeted so that drilling was begun on the 27th. Work was vigorously prosecuted, and by the middle of November the *projecting points* had been removed from the en-

tire reef, which covered a space about 1,200 feet long by from 30 to 120 feet wide. In addition, a number of high points in the channel and on the right-hand reef were found and removed, as will be seen by the accompanying plan. Work was suspended for the season by reason of high water on November 21, 1887.

The effect of this work on navigation has been to increase the safe channel from 150 to 250 feet in width, and to materially assist the passage of tows and vessels by straightening and deepening a very crooked and dangerous chute.

A force of carpenters was employed in repairing the cross-dam and the guiding-dike on the north side of the canal. With the work done last season it is expected that the cross-dam will need very little repair for several years.

The cost of the work for the season was $10,361.52, of which $8,373.39 were expended on the Indiana Chute and $1,988.13 on repairs of the dam and guiding-dike.

The Falls gauges were read daily between the stages of 7¼ and 8¼ feet on the upper canal gauge, and at intervals of one-half foot above. Descending vessels used the Falls 126 days, and ascending vessels 29 days. During this time 1,875 vessels passed, representing a total undertonnage of 1,000,467 tons, and carrying 10,720,800 bushels of coal, besides a large amount of miscellaneous merchandise.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

C C 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL.

The canal was opened for the passage of commerce during the entire year, with the exception of twenty days. It was closed eighteen days on account of high water, and two days by ice. No accident or delay of consequence has occurred, except such delay as was occasioned by the limit of capacity of lockage when a number of coal tows arrived together. Necessary minor repairs have been made to lock machinery, buildings, fences, bridges, dredges, scows, etc. A new winding-drum was attached to engine at middle gates, on the south side of locks, to pull boats in and out of locks, and relieve the boiler on the north side, which furnishes steam for the electric-light engine.

The shops and other buildings which had to be moved on account of the enlargement of the basin are all in place and fitted up for their uses, with the exception of one store-house.

A considerable portion of the large deposit of mud on the old canal walls and berms has been removed, and the slopes are being made to conform to the new condition of the grounds between the old and new locks, arising from the raising of their level, with the material from the basin enlargement. The tow-boat was docked and hog chains put on her, as it was found that the longitudinal steel bulkheads did not keep her in shape.

The water-pipe connected with the force-pump on north side of locks has been extended to the shops as a means of protection in case of fire.

A complete new set of chains for moving the gates of the new locks has been purchased, and most of the chains placed on the gates.

The dredging during the year has been less than usual owing to difficulty in working when the water was extremely low; the condition of the canal in this respect, however, is very fair. The building of a second new dredge has been postponed from year to year, as the old dredge continued to do its work. It is possible that a necessity will arise for commencing the construction of this new dredge during the coming year, but a thorough repair of the old one will, it is believed, make it serviceable for some time yet.

The two new mud-scows estimated for last year have not been built, owing to the disarrangement of the shops.

The old tow-boat *Walker Morris*, which had been in service many years on the canal, was sold at public auction.

Contract has been entered into with P. H. Sweeney to furnish the material and build the revetment on the lower part of the slopes at the new locks. It is expected that he will begin the work in a few days.

New guard-gates at both old and new locks estimated for last year were not built, as the old gates continued to hold. It is deemed necessary to provide for new ones during the coming year.

The stone-wall of the canal and the face of the rock beneath, as left in the excavation, contain many rough and jagged points which are dangerous to passing boats and should be removed. The channel at the lower entrance to the canal should be excavated to give the same depth of water as there is on the lower miter-sill, that is, 4.9 feet at the extreme low water of last season. In 1873 this work was commenced, but owing to a rise in the river the work was not completed. Owing to the rare occurrence of extreme low water no great inconvenience was experienced at this point until last summer, when a number of boats found difficulty in passing, and on one occasion the new locks could not be entered at all.

A survey has been made of this part of the channel and develops the fact that excavation is needed for a distance of 1,300 feet below the lock, and to provide a channel 150 feet wide would require the removal of 8,471 cubic yards of rock. This excavation should eventually be made, but for present needs it is deemed sufficient to excavate the area which has a less depth than 3 feet, and for a channel 100 feet wide. This would necessitate working over a length of about 300 feet, and require the removal of about 2,400 cubic yards. Estimating the cost at $8 per yard, the sum of $19,200 would be required.

The supply of water for the use of the employés of the canal is quite a serious question. The canal water is utterly unfit for use, and much objection is made to the river water on account of the drainage of the cities of Louisville and Jeffersonville.

The superintendent of the canal submits an estimate of $2,000 for extension of pipes of the city water-works to the locks, and this is probably the best solution of the question.

The enlarging of the basin of the canal is being prosecuted with funds derived from the appropriation for improvement of the Falls of the Ohio River, and the work will be embraced in the report for that improvement.

The usual tables of expenditures and of commerce, and the report of Mr. Thomas H. Taylor, superintendent of the canal, are appended.

The estimate for cost of operating and care of the canal for the fiscal year ending June 30, 1889, is as follows:

Items.	Amount.	Items.	Amount.
Regular pay-rolls	$34,560	Two new mud-scows	$4,000
Extra labor	5,000	Work, dressing canal wall	1,000
General repairs	5,000	Excavation of channel, lower entrance	19,200
Miscellaneous, fuel, oil, etc	5,000	Extension of city water pipes to locks	2,000
Repair of old dredge	3,000	Contingencies	5,000
New guard-gates, new locks	8,000		
New guard-gates, old locks	2,345	Total	100,105
Revetment of slopes above lock walls	6,000		

It will be observed that $20,345 of this estimate are for items which appeared in last year's estimate, viz, guard-gates, paving-slopes, and

scows; and that the cost of operating the canal during the past y
was correspondingly less than the estimate.

Financial statement for the fiscal year ending June 30, 1888, operating and care of Lo ville and Portland Canal, Kentucky.

Receipts.	Amount.	Expenditures.	Amo
Auction sale	$1,525.00	Office and general administration	$12,52
Dry-dock	704.61	Canal and locks	25,19
Dredging	155.00	Dredging	15,70
Rent	97.50	Total	53,42
Pumping	12.50		
Total	2,494.61		

Statement showing cost of passing boats and freight through the Louisville and Portl Canal for the fiscal year ending June 30, 1888, including all expenditures.

Per lockage $5
Per boat 4
Per ton .....

Detailed statement of expenditures, operating and care of Louisville and Portland Canal, the fiscal year ending June 30, 1888.

Date.	Office and general administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Tot
1887.								
July	$920.00	$49.08	$117.32	$1,086.40	$1,255.00	$128.15	$397.41	$1,78
August	850.00	46.48	110.64	1,007.12	1,255.00	93.00	181.16	1,52
September	795.00	17.24	124.04	936.28	1,155.00	203.07	309.36	1,76
October	980.00	9.78	135.94	1,125.72	1,255.00	165.39	1,043.05	2,46
November	795.00	17.80	122.69	935.49	1,255.00	202.18	511.72	1,96
December	850.00	49.99	69.27	969.26	1,255.00	330.97	152.33	1,73
1888.								
January	795.00	41.46	144.43	980.89	1,260.00	176.04	997.73	2,43
February	980.00	44.31	81.92	1,106.23	1,260.00	205.35	396.13	1,86
March	855.00	6.08	172.32	1,033.40	1,260.00	298.85	937.26	2,49
April	1,015.00	26.30	114.24	1,155.54	1,260.00	171.00	911.96	2,34
May	850.00	4.30	251.83	1,106.13	1,260.00	167.00	966.69	2,39
June	844.50	20.03	217.35	1,081.88	1,260.00	169.13	993.05	3,42
Total	10,529.50	332.85	1,661.99	12,524.34	15,090.00	2,310.13	7,779.85	25,19

Date.	Dredging.				Aggreg
	Labor.	Supplies.	Repairs.	Total.	
1887.					
July	$875.00	$548.00	$277.91	$1,700.91	$4,56
August	875.00	324.00	720.16	1,919.16	4,45
September	875.00	246.82	72.47	1,194.29	3,85
October	875.00	335.10	70.74	1,280.84	4,87
November	875.00	171.72	110.93	1,157.65	4,06
December	875.00	390.27	47.19	1,312.46	4,62
1888.					
January	875.00	230.55	86.27	1,191.82	4,60
February	875.00	302.05	56.29	1,233.34	4,20
March	875.00	275.00	62.56	1,212.56	4,74
April	875.00	278.94	53.82	1,207.76	4,70
May	875.00	322.88	25.23	1,223.11	4,72
June	875.00	185.47	12.44	1,072.91	4,57
Total	10,500.00	3,610.80	1,596.01	15,706.81	53,42

Money statement.

July 1, 1887, amount available		$34,863.97
Allotment from amount appropriated by act of July 5, 1884		77,805.00
		112,668.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$48,809.25	
July 1, 1888, outstanding liabilities	4,646.51	
July 1, 1888, dropped, not drawn	58,565.00	
		112,020.76
July 1, 1888, balance available		648.21

Abstract of proposals for stone revetment received in response to the attached advertisement dated April 25, 1888, and opened May 26, 1888, by Maj. Amos Stickney, Corps of Engineers, U. S. A.

No.	Names of bidders.	Face stone, 1,400 cubic yards (more or less), per cubic yard.	Backing, 700 cubic yards (more or less), per cubic yard.	Cost of building revetment per square yard.	Total cost (4,000 square yards).	Remarks.
1	Phillip Donohue	$4.85	$0.90	$0.38	$8,940	
2	Roderick Mackenzie	4.48	1.15	.56	9,317	
3	G. D. Hamilton	2.60	1.10 1.40	.45	6,210 6,420	Gravel. Rock.
4	William F. Shanks	6.15	1.10	.50	11,380	
5	Patrick H. Sweeney	2.22	74½ 1.20	.39½	5,209 5,528	*Gravel. *Rock.
6	Joseph Nevin	1.90	1.50	.74	6,670	

*Recommended for acceptance.

Abstract of proposals for paints, oils, etc., received in response to the attached advertisement dated May 9, and opened June 9, 1888, by Maj. Amos Stickney, Corps of Engineers, U. S. A.

Description of articles.	Number (more or less).	Unit of quantity.	1. Bid of W. W. Hite & Co.	2. Bid of Peaslee, Gaulber & Co.
Globes, lantern, tubular W	24	Number		10 cts. each.
Grease, axle	12	Boxes		5 cts. per box.*
Lanterns, tubular W	12	Number		60 cts. each.
Lead, white, in oil	300	Pounds	6 cts. per lb	5¾ cts. per lb.
Oil, black (lubricating)	150	Gallons	11 cts. per gall	13 cts. per gall. by bbl.†
Oil, cylinder, Bell's cylinder	30	... do	$1 per gall	90 cts. per gall.
Oil, headlight 175°, coal	20	... do	15½ cts. per gall	17 cts. per gall.
Do	10	Barrels	$6.75 per bbl	13½ cts. per bbl. by bbl.
Oil, lard, W. S., extra	250	Gallons	65 cts. per gall	62 cts. per gall. by bbl.
Oil, linseed, boiled	60	....do	59 cts. per gall	59 cts. per gall.
Oil, lubricating, XXX sperm, engine.	50	....do	35 cts. per gall	22 cts. per gall. by bbl.‡
Paint, oxide of iron, R. M	50	....do		55 cts. per gall. by bbl.§
Paper, sand, asst	10	Quires		25 cts. per quire.
Putty	20	Pounds		3 cts. per lb.
Turpentine	10	Gallons	45 cts. per gall	45 cts. per gall.

*Diamond, recommended for acceptance. † Summer, 10 cents per gallon; winter, 13 cents per gallon. ‡ If less than barrel, 27 cents per gallon, Peerless, light color. § If less than barrell, 60 cents per gallon.

Abstract of proposals for coal received in response to the attached advertisement dated May 9, 1888, and opened June 9, 1888, by Maj. Amos Stickney, Corps of Engineers, U. S. A.

No.	Name of bidder.	Kind of coal.	Quantity (more or less).		Price.	
			Bushels.	Tons.	Per bushel.	Per ton.
*1	Austin H. Dugan	Best Pittsburgh	11,800		$0.11	
		Second pool, Pittsburgh	900		.11	
		Ohio River or Kanawa	34,500		.09	
		Anthracite egg		8		$7.50
		Anthracite nut		8		7.50
		Total cost			$4,622	

* Recommended for acceptance.

Abstract of proposals for manilla rope received in response to the attached advertisement dated May 9, 1888, and opened June 9 by Maj. Amos Stickney, Corps of Engineers, U. S. A.

Kind of rope.	Quantity (more or less).	1. Bid of W. W. Hite & Co. (per pound).	2. Bid of M. Nippert & Co. (per pound.)*
	Pounds.	*Cents.*	*Cents.*
⅝ inch diameter	25	11½	11½
¾ inch diameter	50	11½	11½
1 inch diameter	150	11½	11½
1¼ inches diameter	250	11½	11½
1½ inches diameter	1,250	11½	11½
1¾ inches diameter	1,000	11½	11½
2 inches diameter	1,150	11½	11½
Total cost		$445.62	$445.62

*Recommended for acceptance.

Abstract of proposals for furnishing and delivering forage at the Louisville and Portland Canal received in response to the attached advertisement dated May 9, 1888, and opened June 9, 1888, by Maj. Amos Stickney, Corps of Engineers, U. S. Army.

Articles.	Quantity (more or less).	1. Bid of George Becker.	2. Bid of B. B. Conner.*
		Cents.	*Cents.*
Hay, timothy ... pounds	10,000	.95	.94
Oats, black ... bushels	300	.40	.38
Straw, wheat ... pounds	500	.35	.40
Bran, middlings ... do	600	.85	.90
Total cost		$281.85	$215.40

* Recommended for acceptance.

Abstract of proposals for ice received in response to the attached advertisement dated May 9, 1888, and opened June 9, 1888, by Maj. Amos Stickney, Corps of Engineers, U. S. A.

Delivered to—	Quantity (more or less) daily.	Bid of Locke & Jacquemin per pound.*
	Pounds.	*Cents.*
507 West Chestnut street	10	.40
Branch office, Third and River streets	10	.40
Locks of Louisville and Portland Canal	75	.40
Total cost		$30

* Recommended for acceptance.

ABSTRACTS OF CONTRACTS.

Name: Patrick H. Sweeney. *Date:* June 16, 1888. *Purpose and consideration:* That the said Patrick H. Sweeney shall furnish all the labor and material necessary for, and build 4,000 square yards, more or less, of a stone revetment on the earthen slopes at the locks of the Louisville and Portland Canal, at Louisville, Ky., as designated by the engineer officer in charge. That the said Maj. Amos Stickney shall pay the said Patrick H. Sweeney for the said material and labor, as follows: For face stone, $2.22 per cubic yards; for gravel backing, 74½ cents per cubic yard; for building revetment, 39½ cents per square yard.

Name: Austin H. Dugan. *Date:* June 22, 1888. *Purpose and consideration:* That the said Austin H. Dugan shall furnish coal for use on the Louisville and Portland Canal and in offices at Louisville, Ky., for the fiscal year ending June 30, 1889, as follows: 34,500 bushels, more or less, of Ohio River or Kanawha coal; 11,800 bushels, more or less, of the best Pittsburgh coal; 900 bushels, more or less, of second pool Pittsburgh coal; 8 tons, more or less, of anthracite egg coal; 8 tons, more or less, of anthracite nut coal. That the said Major Amos Stickney shall pay for the said coal, when delivered as required, at the following rates, viz: For the Ohio River or Kanawha coal, 9 cents per bushel; for the best Pittsburgh and second pool Pittsburgh coal, 11 cents per bushel; for anthracite nut and egg coal, $7.50 per ton.

REPORT OF MR. THOMAS H. TAYLOR, SUPERINTENDENT OF THE OPERATIONS OF LOUISVILLE AND PORTLAND CANAL FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

SIR: The canal was open and in operation the entire year with the exception of twenty days, eighteen of which was caused by high water and two days lost by ice.

Although the river was extremely low, the old locks were only used to pass one steam-boat, this on account of the channel being deeper. The organization of the regular force of the canal remains as heretofore, with the addition of an extra man on the tow-boat as striker or assistant engineer. The force consists of 1 superintendent, 1 assistant superintendent, 1 clerk, 1 traffic manager, 2 messengers, 1 carpenter, 1 pilot, 1 blacksmith, 1 first lockmaster, 1 second lockmaster, 1 engineer of tow-boat, 2 engineers of dredges, 1 machinist, 3 engineers of locks, 8 lock hands, 1 lock watchman, 2 dipper tenders, 4 steam-boat hands, 1 blacksmith striker, 1 teamster, 1 striker, 4 dredge hands, 1 dredge watchman, 1 steam-boat watchman, and 1 bridge tender.

The work of passing vessels through the canal has been promptly and satisfactorily performed. No accident or delay worth mentioning has occurred. The enlarging of the canal basin being under the improvement of the falls of the Ohio, a report of this work will be made by assistant engineer in charge. Owing to this work, that of the Louisville and Portland Canal has been smaller than it would have otherwise been. The kitchen of residence at locks has been repaired. Covers have been made for well holes in lock-walls. The mud was removed from the walls of the old canal that has been accumulating for several years, and the slopes of the canal commenced. The tow-boat *Major McKenzie* was docked and hog chains put on her; 5 new wickets were put on new lock-gates, a number of check posts were put down at head of canal, a new coal-house for blacksmith shop was built adjoining shops. New boxing was put on steam-pipes on south side of canal, and on north side from boiler-house to lower engine-house. The steam-pipe that was put under ground from boiler-house to upper engine was taken up and replaced on the wall.

The shelter house on old canal was moved nearer to the locks. The thenard shutters were repaired. All the buildings of the Louisville and Portland Canal that were moved and put in new positions were repaired, battoned, and are now being whitewashed. A new roof was put on store-house, a new floor put down, and the building thoroughly repaired. A new floor was placed in planing-mill, new lifting-doors hung, new belting put on machinery, and everything put in thorough repair; when this building was moved all the machinery, etc., had to be stored until the house was rebuilt. The mud-scows have all been docked, calked, and repaired. A new winding drum, with necessary machinery, has been attached at boiler-house on south side of new canal, to relieve the one on north side at night, the boiler on that side not furnishing sufficient steam to use electric light, operate the gates, and work winding drum at same time. A hawser-box was built for tow-boat, also life-floats and buoys were made. The boat has been repaired by the hands regularly employed on her. Davits for life-boat have been made. New capstan bars have been made for guard-gates, new locks. A new dipper handle has been placed on Dredge No. 1. A fence has been built around residence of bridge tender, at Eighteenth Street Bridge. Lattice-work has been built around pump-house and closet at the office of canal. Three drawing-boards were made for use at United States Engineer office. New coal-houses were built for the office and residence at locks. A new boiler has been put in engine-house of

and the road on north side of locks has also been covered
this year has been less than last year on account of extr
which prevented the tow-boat and dredges from workin
they draw more water than was in it at that time.
worked in upper end of canal where the tow-boat could
them. Dredge No. 1 at basin of locks, and each scow ha
old canal and dumped by hand, taking about three hour

During the coming year it will be necessary to put t
complete repair, as there is danger of her sinking almost
should be built as soon as possible. Two new scows, h
each should be built. The iron dredge *Louisville* would
same time No. 1 could fill one of those holding 40 yards. I
and new locks should be built early the coming year, an
canal force, it will be necessary to set up new launch-wa

The public road leading from bridge across new locks, t
into Shippingport will have to be made, and a new fen
shops, etc. Little repairs will be required on thenard a
has during this year injured them scarcely any.

The concrete on lock-walls will require repairing. Wa
the city water-works to the locks. The prospects are t
hauled, as it was during the present year. The contract
locks has been let, and work on same will soon begin. T
ditional force of laborers, and the water supply from ci
exhausted. The water in the river at this point contai
Louisville and Jeffersonville makes it unfit for drinking
likely produce sickness. The approaches to bridge acros
will have to be replaced by new ones, and the bridges sh
of the canal, Mr. J. B. Quin, has compiled a complete tab
commerce passed through the canal and falls of the Ohi
uable addition to the Annual Report.

The stone wall of canal contains a great many rough an
to passing boats. I would recommend that stone-cutters
wall.

The old tow-boat *Walker Morris* was condemned and so
ing $1,525. Inclosed with this report will be found ap
years 1889 and 1890. Also statement of receipts of Loui
during the fiscal year.

Very respectfully, your obedient servant,

Superintendent Lou

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

Detailed statement of dredging for the fiscal year ending June 30, 1888.

Month.	Working days.	Lost by high water.	Lost by ice.	Sundays and holidays.	Lost by repairs.	Lost by coal runs.	Total days lost.	Days at work.	Excavation.
1887.									*Cu. yds.*
July	26	.....	.....	5	2	.....	7	24	9,095
August	27	.....	.....	4	.....	.....	4	27	17,480
September	26	.....	.....	4	2	.....	6	24	16,320
October	26	.....	.....	5	1	.....	6	25	13,680
November	26	.....	.....	4	5	.....	9	21	8,200
December	26	.....	2	6	1	.....	9	22	6,720
1888.									
January	26	.....	20	5	6	.....	31	.....	300
February	25	2	.....	4	4	4	14	15	4,840
March	27	6	.....	4	3	10	23	8	4,400
April	25	.....	.....	5	.....	18	23	7	2,360
May	27	.....	.....	4	1	4	9	22	12,600
June	26	.....	.....	4	4	.....	8	22	8,200
Total	313	8	22	54	29	36	149	217	104,195

Comparative statement of dredging Louisville and Portland Canal, 1882–'88.

Date.	Total.	Total cost repairs, salaries, and supplies.	Daily average excavation.	Average daily cost.	Days at work.
	Cub. yds.		*Cub. yds.*		
1882–'83	111,916	$18,382.39	571	$5,036	196
1883–'84	100,760	14,148.30	458	3,876	220
1884–'85	79,975	21,298.27	457	5,835	175
1885–'86	102,312	15,369.31	522	4,213	196
1886–'87	106,720	12,862.44	606	3,524	176
1887–'88	104,195	15,706.81	480	4,303	217

Statement of vessels passed through the Louisville and Portland canal during the fiscal year ending June 30, 1888.

Date.	Passenger boats.		Tow-boats.		Coal-boats.		Government boats.	
1887.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
July	23	7,462	129	16,444	.....	.....	18	1,424
August	28	6,969	123	15,465	.....	.....	11	1,066
September	52	10,098	49	6,320	.....	.....	2	200
October	66	12,759	48	6,381	.....	.....	2	161
November	58	10,903	38	4,229	.....	.....	.....	.....
December	98	22,146	78	6,916	.....	.....	2	180
1888.								
January	53	21,261	45	3,742	34	14,626	14	800
February	77	33,872	87	7,770	160	59,326	80	5,001
March	75	37,512	77	7,567	193	83,896	11	580
April	79	28,101	111	9,386	186	79,970	8	460
May	123	48,042	87	8,982	195	85,024	33	2,080
June	118	46,335	65	5,558	18	7,740	9	510
Total	850	285,460	937	98,760	786	330,582	190	12,462

Statement of vessels passed through the Louisville and Portland canal, etc.—Continued.

Date.	Square barges.		Model barges.		Small craft.	Total.		Lockages.
1887.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*No.*	*Tons.*	*No.*
July	90	12,940	11	3,106	14	285	41,376	328
August	95	12,020	1	133	26	284	35,653	322
September	72	6,167	.....	.....	23	198	22,785	242
October	122	13,386	.....	.....	40	278	32,687	268
November	94	8,422	.....	.....	18	208	23,554	220
December	211	36,896	7	2,388	19	415	68,526	432
1888.								
January	242	52,068	15	4,517	6	409	97,012	222
February	221	59,300	19	6,071	5	639	171,340	434
March	247	48,322	10	3,024	5	628	180,901	422
April	336	64,624	21	6,848	5	746	189,389	463
May	471	197,445	30	9,465	16	955	351,038	730
June	168	33,611	24	7,836	24	426	101,590	562
Total	2,369	545,199	138	43,388	201	5,471	1,315,851	4,655

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1888.

Date.	Coal.	Salt.	Oil.	Whisky.	Tobacco.	Cotton.	Lumber.	Corn and wheat.	Iron ore.	Steel rails.
1887.	*Bush.*	*Bbls.*	*Bbls.*	*Bbls.*	*Hhds.*	*Bales.*	*Feet.*	*Bush.*	*Tons.*	*Tons.*
July	45,107	17,207	334	115	2,098	329	316,000	43,227	2,646	.....
August	16,000	773	217	69	1,020	138	1,709,000	20,091	3,559	.....
September	5,555	462	1,341	141	192	195	205,000	10,057	47	.....
October	70	641	307	161	415	512	371,000	5,803	10	.....
November	.....	384	341	119	165	1,137	460,000	4,973	11½	.....
December	68,700	9,202	1,019	260	704	1,013	832,000	4,537	542½	50
1888.										
January	304,122	5,543	4,481	676	172	5,622	629,000	960	4,007	.....
February	5,282,000	4,859	8,566	625	656	8,014	1,217,000	4,413	4,290	2,200
March	6,676,500	13,068	7,670	574	264	5,888	950,000	5,319	3,726	5,000
April	6,653,000	12,284	11,721	474	530	8,020	1,070,000	60,927	24,753	.....
May	10,818,000	30,075	18,378	6,109	6,672	11,562	2,319,000	9,783	6,651	609
June	2,143,000	6,211	2,364	1,283	1,837	3,769	1,960,000	8,045	3,611	.....
Total	32,012,054	100,709	56,739	10,606	14,725	46,219	11,038,000	178,135	53,860	7,859

Date.	Produce.	Hay.	Flour.	Molasses.	Cement.	Cattle.	Sugar.	Staves.	Shingles.	Passengers.	Miscellaneous.
1887.	*Bbls.*	*Tons.*	*Bbls.*	*Bbls.*	*Bbls.*	*No.*	*Bbls.*	*No.*	*No.*	*No.*	*Tons.*
July	3,976	1,551	276	1,643	350	288	597	100,000	118,000	1,747	1,890
August	4,746	1,977	452	225	420	257	632	82,000	136,340	1,696	2,989
September	2,889	1,027	659	264	505	552	397	110,000	5,000	1,513	2,140
October	5,350	2,185	512	283	289	339	474	240,000	15,020	1,466	2,373
November	4,576	1,479	568	405	494	1,446	414	260,000	14,230	1,447	2,067
December	4,597	4,696	673	414	229	1,774	538	1,290,000	14,000	1,558	6,578
1888.											
January	2,712	4,924	456	1,772	1,150	1,296	496	1,220,800	150,000	679	7,010
February	2,266	9,006	1,412	4,051	1,460	1,156	763	2,262,350	180,000	1,567	6,4[illegible]
March	922	6,469	1,273	1,721	1,100	1,573	840	1,579,863	100,000	1,381	4,04[illegible]
April	1,030	14,407	1,302	804	325	1,231	3,760	3,347,000	3,520,000	1,209	7,649
May	1,316	5,013	1,920	9,056	1,782	5,728	4,154	1,961,000	1,641,000	2,020	9,010
June	6,636	2,606	732	1,109	720	1,337	2,514	4,708,000	1,309,000	2,290	8,33[illegible]
Total	41,016	55,340	10,235	21,747	8,824	16,977	15,579	17,181,013	7,202,590	18,488	60,57[illegible]

Statement of vessels passed over the Falls of the Ohio River during the fiscal year ending June 30, 1888.

DESCENDING VESSELS.

Month.	Passenger boats.		Tow-boats.		Square barges.		Model barges.		Total.		Days navigable.
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	
January	29	14,367	61	11,414	225	145,622	19	15,200	334	186,603	22
February	41	21,072	24	5,864	229	158,140	60	51,000	354	236,076	24
March	64	33,982	62	10,926	241	153,724	10	8,000	377	206,632	31
April	44	18,804	61	10,499	207	135,628	50	42,000	362	206,931	27
May	23	10,209	26	6,472	3	320	.....	.....	52	17,001	13
June	18	7,370	6	1,280	11	1,344	.....	.....	35	9,994	9
Total	219	105,804	240	46,455	916	594,778	139	116,200	1,514	863,237	126

ASCENDING VESSELS.

January	9	4,437	47	6,487	54	25,105	10	8,100	120	44,129	8
February	13	5,385	53	9,397	55	33,194	17	13,420	138	61,396	5
March	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
April	20	11,498	45	7,681	26	9,926	12	2,600	103	31,705	16
May	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	42	21,320	145	23,565	135	68,225	39	24,120	361	137,230	29
Aggregate	261	127,124	385	70,020	1,051	663,003	178	140,320	1,875	1,000,467	126

Commerce passed the Falls of the Ohio River by canal and by river.

Fiscal years.	Through canal.		Open river.				Total.	
			Descending.		Ascending.			
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1880-'81	4,196	1,124,838	1,220	377,055	503	140,306	5,919	1,642,199
1881-'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882-'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883-'84	4,346	1,070,650	1,384	432,575	301	98,757	6,031	1,601,982
1884-'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885-'86	5,057	1,254,342	1,296	408,619	373	102,536	6,726	1,765,497
1886-'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731
1887-'88	5,471	1,315,851	1,514	863,237	361	137,230	7,346	2,316,318

Statement of commerce passed over the Falls of the Ohio River during the fiscal year ending June 30, 1888.

Articles.		Amount.	Articles.		Amount.
Coal	bushels	10,720,800	Tobacco	hhds	966
Corn and wheat	do	13,840	Cotton	bales	911
Flour	barrels	1,976	Hay	tons	6,149
Sugar	do	5,271	Iron ore	do	25,276
Whisky	do	1,354	Lumber	feet	619,000
[illegible]	do	2,105	Miscellaneous	tons	7,607
Molasses	do	1,288	Passengers		5,561
Meal	do	1,613			

Principal items of commerce passed over the falls and through the canal during the fiscal year ending June 30, 1888.

Articles.	Amount.	Articles.	Amount.
Coal.....bushels..	42,732,854	Cotton.....bales..	47,130
Corn and wheat.....do....	191,975	Lumber.....feet..	11,657,000
Salt.....barrels..	102,685	Staves.....number..	17,181,013
Oil.....do....	58,844	Shingles.....do....	7,202,590
Whisky.....do....	11,960	Cattle.....do....	16,977
Produce.....do....	41,016	Iron ore.....tons..	79,136
Flour.....do....	11,848	Steel rails.....do....	7,859
Molasses.....do....	23,035	Hay.....do....	61,489
Cement.....do....	8,824	Miscellaneous.....do....	68,185
Sugar.....do....	20,850	Passengers.....do....	24,049
Tobacco.....hhds..	15,651		

C C 4.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

IMPROVEMENT BELOW VINCENNES.

Work on this portion of the river during the year included the procuring of stone and commencement of masonry of the lock at Grand Rapids, near Mount Carmel, extension of levee at Grayville Bend, repair of snag-boat, building new hull for dredge, care of plant, etc.

LOCK AT GRAND RAPIDS.

In the beginning of the year work was in progress excavating at site of lock and removing remains of old lock preparatory to the commencement of the new structure.

This work was found to be much more extensive and costly than was anticipated, and it was not until August 29 that stone-laying was begun, and but 695 yards were laid during the year, on account of difficulties and delays occasioned by lack of stone, as described in the report of Mr. O. L. Petitdidier.

The contractors, Carmody and Mapel, after five extensions of their time, utterly failed to deliver the amount agreed upon, and a new contract could not be entered into in time to keep the supply equal to the requirements of the builders.

A new contract with Charles E. Rees was made October 28, 1887, but his delivery is also very slow, and it has been necessary to extend his time from June 1, 1888, to September 1, 1888.

The work of building the lock is being performed by hired labor under the direction of this office. The arrangements made for carrying on the work would admit of its rapid progress if the stone was promptly delivered.

The first contract required the delivering of the stone at the lock-site, but owing to the difficulty under which the contractor labored, for want of boats, in moving the stone on the river from the railroad at Mount Carmel to the lock-site, about 1½ miles, it was thought that more promptness would be insured by receiving the stone at Mount Carmel and using the Government boats.

The second contract was, therefore, for delivering at Mount Carmel.

The cost of this work will be increased over previous estimates from unavoidable causes, which are described in Mr. Petitdidier's report.

GRAYVILLE BEND.

The levee which was built during the season of 1886–'87 to close the cut-off at this place has stood well.

During the past year some small repairs were made and the levee extended 250 feet, the extension containing 2,583 cubic yards of earth. To complete the work at this place requires now the protection of the banks from erosion.

SNAG-BOAT.

The repairs of snag-boat were completed, but owing to the extreme low stage of the river last season it was deemed inadvisable to start her to work. She will probably be put to work this season.

DREDGE.

The hull of the dredge having become unserviceable a new hull was built and the machinery transferred, part of the expense being paid from the appropriation for White River, as the boat is used on both rivers.

ESTIMATES.

The following table of estimates is presented for important work in this part of the river:

Completing lock and dam at Grand Rapids	$140,000
Work at Widow Goss and Skidmore bars	20,000
Work at Little Chain	20,000
Work at Grand Chain	25,000
Protection of bank at Grayville	11,000
Dam at Little Chain Cut-off	2,000
Removal of rock at Marshall's Ferry	1,000
Dam at New Harmony	25,000
Work at Coffee Island Chute	2,600
Channel through White River Shoals	20,000
Repairs to works, maintenance of plant, contingent expenses	10,000
	276,600

For a statement of details of the work attention is invited to the appended report of Mr. O. L. Petitdidier, assistant engineer.

Money statement.

July 1, 1887, amount available		$46,436.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$22,645.58	
July 1, 1888, outstanding liabilities	3,726.06	
July 1, 1888, amount covered by existing contracts	10,365.77	
		36,737.41
July 1, 1888, balance available		9,698.90
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		69,698.90
Amount (estimated) required for completion of existing project		216,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for hull for dredge, received in response to the attached advertisement dated July 7, 1887, and opened August 9, 1887, in the absence of Maj Amos Stickney, Corps of Engineers, U. S. A., by B. H. Cooper, clerk.

No.	Bidders.	Price per each half.
1	Howard T. Cook	$1,680.50
*2	Mat. Cox	995.00
3	John A. Porter and Samuel C. McClintock	1,415.00

* Recommended for acceptance.

Abstract of proposals for furnishing stone for lock received in response to the attached advertisement dated August 31, 1887, and opened October 1, 1887, by Maj. Amos Stickney, Corps of Engineers, U. S. Army.

DELIVERED ON TOP OF BANK AT SITE OF LOCK.

No. of proposals.	Names of bidders.	Time of completion of delivery of stone.	Special stone (529 cubic yards).	Cut stone, dressed face (950 cubic yards).	Cut stone, quarry face (650 cubic yards).	Squared stone and backing (784 cubic yards).	Total cost.
1	I. V. Hoag, jr.	6 months	$21.00	$15.00	$13.00	$11.00	$42,433.00
2	Salem Stone and Lime Company	July 1, 1888	.....	.....	.....	.....	.....
3	Edward Crumbo and Joseph Melcher	June 1, 1888	25.10	16.90	14.60	11.90	48,152.50
*4	Charles E. Rees	Not stated	20.87	15.87	12.87	8.87	41,436.31

DELIVERED AT RAILROAD SWITCH, NEAR THE RIVER, AT MOUNT CARMEL, ILLINOIS.

1	I. V. Hoag, jr.	6 months	$19.00	$13.00	$11.00	$9.00	$36,607.00
2	Salem Stone and Lime Company	July 1, 1888	20.15	17.65	16.65	11.40	47,196.95
3	Edward Crumbo and Joseph Melcher	June 1, 1888	22.60	14.40	12.10	9.40	40,879.00
*4	Charles E. Rees	Not stated	19.12	14.12	11.12	7.12	36,338.56

*Accepted.

ABSTRACT OF CONTRACTS.

Name: Mat Cox. Date: September 12, 1887. Purpose and consideration: That the said Mat Cox shall furnish one-half of the necessary labor and material, a separate contract being signed for the other half, and shall construct, and deliver at Mount Carmel, Ill., complete, a wooden hull for a dredge-boat. That the said Maj. Amos Stickney shall pay for the said wooden hull the sum of $1,990; one-half of said amount being paid under this contract, and the other half under the aforesaid separate contract.

Name: Charles E. Rees. Date: October 28, 1887. Purpose and consideration: That the said Charles E. Rees shall furnish and deliver at the railroad switch, near the Wabash River, at Mount Carmel, Ill., such quantities of stone as may be directed or required by the said Maj. Amos Stickney, in accordance with the said advertisement and specifiations. That the said Maj. Amos Stickney shall pay for the said stone, when delivered as required, at the following rates, viz: For special stone, $19.12 per cubic yard; for cut stone, dressed face, $14.12 per cubic yard; for cut stone, quarry face, $11.12 per cubic yard; for squared stone and backing, $7.12 per cubic yard.

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *July* 6, 1888.

MAJOR: I have the honor to submit the following report on improvement of Wabash River, Indiana, and Illinois, for the fiscal year ending June 30, 1888:

IMPROVEMENTS BELOW VINCENNES.

The project of improvement adopted for the Wabash River contemplates obtaining the depth of 3½ feet in the channel at low water, it being the aim to obtain this *depth* by means suited to the location of each obstruction.

In accordance with this project, cuts through chains of rock were made, both at Little Chain, Grand Chain, and Coffee Chute; dikes were built at Winkler's Bar, and McIntyre's Bar, dams across cut-offs at New Harmony, Turkey Island Chute, and Little Chain Cut-off, while for the navigation of Grand Rapids near Mount Carmel, a lock and dam has been decided upon as the proper method of improvement.

The removal of numerous snags was also carried on for several years, but discontinued on account of failure of appropriations. No snagging has been done for five years.

There being no appropriation in 1887, no new work could be contemplated, and work was continued according to the project of expenditure contemplated in 1887.

CONDITION OF THE RIVER.

Owing to want of sufficient appropriations no work has been done on the lower portion of the Wabash River for several years, the result being that several of the improvements have been vitiated for want of proper attention and repairs, and at low water the condition of the river is far from satisfactory, there being hardly any navigation during the low-water period.

The various points of obstruction on the river have been treated in detail in my last annual report, and I shall confine myself only to those points where work has been done during the last fiscal year.

GRAYVILLE BEND CUT-OFF, 62 MILES ABOVE MOUTH.

The levee which was rebuilt across this cut-off in 1886–'87 has been successful, having withstood the high water of the winter of 1886–'87 and 1887–'88, and, beyond some few repairs occasioned by cattle and stock feeding on the levee, is in very good condition.

During last fiscal year the damage done to the levee by high water during the winter was repaired, the levee was also extended 250 linear feet westward, grass was sown on new portion of work, and the ends of the levee were protected with brush securely pinned down.

The number of cubic yards put in the new addition to the levee during the fiscal year is 2,583. It is believed that, with some few additional repairs, this improvement will be a permanent one, unless the river banks alongside of the levee should further cave in, and eventually undermine the levee.

Should any additional funds become available during the year, it is proposed to protect the river banks opposite the levee with brush and stone, or by such other means as a further study of the location of improvement would indicate.

LOCK AND DAM AT GRAND RAPIDS, 92½ MILES ABOVE THE MOUTH.

During the past fiscal year the excavation of old lock-walls was continued until the bottom timbers were reached. It was then found that both walls of the old lock, instead of resting on a foundation at same level as that of old lock-chamber, as supposed, had been merely put down on a ledge of rock 5 to 6 feet high, running the whole length of the wall.

This would have been a fortunate circumstance had it not been that for most of its length this ledge was underlaid with a stratum of soap-stone so soft as to render it unsafe to lay any masonry on the superincumbent ledge without great danger of serious settling.

This ledge of rock, which is a soft sandstone belonging to the coal measures, had to be taken out, for the greater part, at considerable expense.

The quantity of rock taken out for the foundation of our new walls, also for lower gate recess and emptying culverts, is very nearly 700 cubic yards.

By care, however, enough of the ledge of rock has been left in place to decrease the amount of our masonry by 350 cubic yards, this being obtained by cutting out the ledge wherever it was found to be good, only as far as to allow a fronting of limestone to be used for two courses, while the third course of masonry is limestone throughout.

The decrease in cost of stone and laying will be 350 cubic yards by 14.69, the average price of our masonry = $5,141.50.

This saving will hardly, however, compensate for the increase in cost of excavation. Stone laying was begun on August 29, 1887, and continued until all available stones were used up. The number of cubic yards laid during the fiscal year being 695; this, added to 125 cubic yards of ledge of rock which had been incorporated in the land wall of lock, brings out the amount of yards of masonry actually in place at 820 cubic yards.

A very much larger quantity of masonry could have easily been laid had the stone been on hand, but owing to the failure of Carmody & Mapel, the former contractors, no more stone could be obtained until a new contract had been entered into.

The stone being furnished so slowly by the contractor, t
to begin to lay stone until sufficient stone be on hand to bri
moderate limits.

The net cost of laying stone varies directly with the ab
having varied last fall from $1.90 per cubic yard to $3.50
cement and all expense except cost of plant and interest o

As an illustration, I will mention that, stone being abun
forty stones per day, while as soon as the quantity of stone
not lay over twenty or twenty-two with our utmost end
penses, with the exception of cement, remained the same.

It is intended to resume laying stone in four or five days,
being made to that effect.

I regret to say that the former estimate for the completi
insufficient and will have to be increased, the increase b
causes:

(1) Increase in average cost of stone of $2.59 per cubic y
stone still remaining to be furnished after failure of the firs

(2) Increase of cost of foundations due to the accumula
débris in lock-chamber since first estimate was made, and
knowledge of condition of the foundation of lock-walls.

The increase will not be far from $7,000. The saving of 35
will, however, as an offset reduce the cost of the work by a

(3) Continual bribbling expenses in maintaining plant, pu
pit, and a thousand and one expenses incident to keepin
several years.

(4) Heavy yearly repairs of damage done by high wat
generally.

(5) Increase of cost of laying stone due to the comparativ
so far received, to the necessity of supporting the walls of
three winters, cleaning up mud and débris from foundatio
and uncertainty of appropriations which did not allow us
needed under one contract, or which prevented contracts t
in the season to secure early delivery.

(6) Extension of contracts beyond time specified increasi
tenance of plant, but also considerably increasing cost of b
site from the railroad switch at Mount Carmel, where the st
as the stone is delivered there regardless of the navigable s

The first estimate of cost of lock and dam was $150,000.
creased as follows:

Increase of contract price of stone

During the present fiscal year the repairs of snag-boat *Richard Ford* were completed, but owing to the extreme low water of last season no snagging was done, as our boat, drawing full 2 feet of water, would have been compelled to work in pools, without the benefit to navigation commensurate with expenses.

I inclose the commercial statistics of the Lower Wabash during the past fiscal year, and I regret to note a decrease in commerce. This is partly due to the extreme low-water stage of last season, and to the poor crops raised on the high lands back of the river during last year, thus retaining the rich crops of the Wabash Bottoms, which were needed at home.

But, in my judgment, commerce on the Wabash River will still either further decline or remain stationary, unless the river is permanently improved to such an extent that navigation is possible at all times of the year, and a depth of at least 6 feet be obtained.

Such results can only be obtained by a judicious and well-studied plan of continuous slackwater navigation.

The Wabash Valley is very fertile, and the area of land cleared and under cultivation is rapidly increasing.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U.S. A.

COMMERCIAL STATISTICS.

List of steam-boats plying on Wabash River during the fiscal year 1887–'88.

Names.	Where plying.	Names.	Where plying.
D. A. Goodin	Vincennes to Mount Carmel.	A. Carney	White River to mouth of Wabash.
Montezuma	do	John R. Hugo	New Harmony to mouth of Wabash.
Jumbo, floating saw-mill.	do	E. G. Rager	do
Kid, floating saw-mill	do	J. P. Drouillard	do

Amount of freight carried on the Wabash River below Vincennes during the fiscal year 1887–'88.

Articles.	Quantity.	Articles.	Quantity.
Grain (corn and wheat) bushels	50,000	Strips or felloes pieces	82,400
Corn do	200,000	Spokes number	124,800
Wheat do	20,000	Hickory butts cords	400
Lumber feet, B. M.	668,000	Saw logs, rafted and sawed by saw-mills along the river	5,010,000

IMPROVEMENT ABOVE VINCENNES.

No work was done during the year above Vincennes on account of there being no funds available.

The condition of the river is becoming worse as snags accumulate in the channel.

A new cut-off about 20 miles above Vincennes has much enlarged, and the lodgment of numerous snags at the head of the cut off threatens a total obstruction of navigation at this point in low water.

The removal of snags is the most urgent work in this part of the river.

Money statement.

July 1, 1887, amount available	$70.08
July 1, 1888, outstanding liabilities	10.05
July 1, 1888, balance available	60.03
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,060.03
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *July* 4, 1888.

MAJOR: I have the honor to submit the following report on the improvement of the Wabash River above Vincennes, during the fiscal year 1887–'88.

No appropriation having been made in 1887 and the funds on hand being almost exhausted, no work was done on this portion of the river during the fiscal year.

CONDITION OF THE RIVER.

The portion of the river, 90 miles in length, between Vincennes and Terre Haute is not in as good a condition as formerly, on account of the numerous snags which are again obstructing the channel in various places.

An additional obstruction on the river is caused by a new cut-off, Wolf's Cut-off, 20 miles above Vincennes, which has enlarged in the last two years to such an extent that at low water, very nearly the whole volume of the river passes through it, so that steam-boats can not go around the bend, but are compelled to pass through the cut-off.

Hundreds of snags having lodged at the head of this cut-off, it is with much difficulty that steam boats can pass through at low water, and unless the snags are removed soon navigation will again be cut in two between Vincennes and Terre Haute.

There are also other portions of the river where dredging and works of contraction would prove beneficial, but the most urgent work is the removal of snags.

It is intended, should there be any money available during the present fiscal year, to resume removal of snags from the channel in the order of their hurtfulness to navigation.

There has been some falling off in the commerce carried on the river during the year. This is to be attributed in part to the poor crops of last year, and also to the unprecedented low water of the summer and fall of 1887, which precluded any navigation.

I think, however, that the navigation of this portion of the river will be entirely successful only when a system of locks and dams has been constructed.

I append the commercial statistics of this portion of the river during the fiscal year.

Estimate to be the same as in our last annual report to Chief of Engineers.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Amount of freight carried on Wabash River above Vincennes during the fiscal year 1887–'88.

Articles.	Quantity.	Articles.	Quantity.
Corn ... bushels	205,770	Staves and heading ... number	10,000
Wheat ... do	103,242	Hoop poles ... do	74,700
Oats ... do	52,364	Vinegar ... barrels	74
Rye ... do	649	Merchandise ... pounds	1,147,357
Potatoes ... do	1,140	Shingles ... number	150,400
Coal ... tons	11,157	Miscellaneous items ... pounds	74,300
Lumber ... feet, B. M.	808,500	Passengers ... number	1,037
Flour ... barrels	2,350	Saw-logs rafted and sawed by mills along the river, approximate only	5,250,000
Salt ... do	3,200		

The steam-boats *Ida Lee*, *Rosedale*, *Diana*, and *Crown Point* were plying regularly on Wabash River between Vincennes and Terre Haute during the fiscal year 1887–'88.

Besides these the steam-boats *Dauntless*, *Juniata*, *Mallard*, *John and Henry*, and *Little Joker* are located at Terre Haute and making irregular trips both above and below Terre Haute.

C C 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The work done during the year has consisted in the continuation of the improvement at Kelly's Ripple by dredging rock previously blasted. During the first half of the fiscal year no work was done, as the water was too low to get the dredge from the Mount Carmel Lock up to Kelly's Ripple. In August a contract was made for building a new hull for the dredge. This was delivered, machinery transferred, and dredge started to work May 7, on the cut in the chute which had been commenced the previous year. This cut was nearly completed June 20, when the dredge was started on another cut which will make the channel 75 feet wide.

About 5,190 yards of rock have been removed during the year.

The estimate of last year for continuation of the work on the lower part of the river is repeated. Work above Hazleton is useless until the bridge at that point is made passable.

Completing work at Kelly's Ripple	$8,000
One year's snagging	4,000
Dredging	4,000
Care of plant and contingencies	1,500
Total	17,500

The report of Assistant Engineer O. L. Petitdidier is appended.

Money statement.

July 1, 1887, amount available		$4,940.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,226.04	
July 1, 1888, outstanding liabilities	366.19	
		2,592.23
July 1, 1888, balance available		2,348.26
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,348.26
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for hull for dredge, received in response to the attached advertis dated July 7, 1887, and opened August 9, 1887, in the absence of Maj. Amos Stic Corps of Engineers, U. S. A., by B. H. Cooper, clerk.

No.	Bidders.	P per h
1	Howard T. Cook	$1,
*2	Mat. Cox	
3	John A. Porter and Samuel C. McClintock	1,

* Recommended for acceptance.

ABSTRACT OF CONTRACTS.

Name: Mat. Cox. Date: September 12, 1887. Purpose and consideration: the said Mat. Cox shall furnish one-half of the necessary labor and material, a rate contract being signed for the other half, and shall construct, and deliv Mount Carmel, Ill., complete, a wooden hull for a dredge-boat. That the said Amos Stickney shall pay for the said wooden hull the sum of $1,990; one-half of amount being paid under this contract, and the other half under the aforesaid rate contract.

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, Ill., *July* 2, 18

MAJOR: I have the honor to submit the following report on improvement of W River, Indiana, during the fiscal year 1887–'88.

No appropriation was made for the improvement of this river during the year

The work done during the fiscal year 1887–'88 has consisted in continuing impr ment at Kelly's Ripple, by removing, by means of a dredge, rock already blaste in the chute, it being the aim to widen this chute until a clear width of 75 feet a water is obtained.

Unfortunately, when the dredge, which was in use at the lock-site at Grand R on Wabash River, became available, the stage of water was such that the dr could not be taken to Kelly's Ripple, so that no dredging was done during the half of the fiscal year.

In the mean time, the hull of dredge, which was nearly ten years old, had be so rotten and leaky that it became doubtful whether it could be kept afloat thr the winter.

A contract for a new hull for dredge was therefore entered into in August, The contract price for furnishing and delivering a new hull being, $1,990, one was charged to the Wabash River, as the dredge is used equally by both rivers.

The hull was completed in December 1887, and delivered on February 6, 1888.

The work of transferring machinery to the new hull was commenced on Ap 1888, and continued until May 4, when the dredge was taken up to Kelly's Rippl

Work was resumed on May 7 on the cut which had been begun in the fall of this cut being nearly completed on June 20, when the dredge was started on its cut, increasing the clear width of chute from 65 to 75 feet.

On June 30 the last cut had been completed for a distance of 325 feet from lower end of chute.

The work done at Kelly's Ripple during the last fiscal year is as follows:

Linear feet of cut dredged (about 12 feet wide)	1
Cubic yards removed	5
Number of days worked with dredge	
Average daily progress:	
Linear feet	3
Cubic yards	10

CONDITION OF THE RIVER.

The river is not in as favorable a condition as desired, for, although the requi depth of 3½ feet, adopted in project of improvement, has been more than attained Kelly's Ripple, which was formerly an impassable obstruction at low water, yet

low water there are many sand-bars where the channel depth will not exceed 2 feet, while numerous snags in the bends are a constant source of danger.

I append the commercial statistics of the river from Hazleton to its mouth.

It will be seen that the amount of navigation and commerce has become unimportant during the year.

This is due to several causes, one of which is the continuous unprecedented low water of 1887; another the poor crops of last fall, so that the quantities of freight waiting for shipment were very materially reduced.

The bad location of draw of railroad bridge, 2 miles above Hazleton, has also an influence in keeping out of the river the larger steam-boats.

But, in my judgment, the depth of 3½ feet, which the present project contemplates, even if it could be obtained without continuous works of improvement, is insufficient to allow steam-boats to compete efficiently with the railroads, and it is only after a greater depth of water, say 6 feet, has been obtained by means of locks and dams, that the river navigation can once more take its legitimate place.

During the present year it is proposed to complete the improvement at Kelly's Ripple.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Amount of freight carried on the White River during the fiscal year 1887–'88.

Designation of freight.	Unit of quantity.	Quantities.
Logs towed by steam-boats	Feet, B. M	300,000
Corn and wheat	Bushels	125,000
Logs handled by saw-mills, which have been handled by the water route from Hazleton Bridge to mouth of White River.	Feet, B. M	780,000

List of steam-boats plying on, or which have made various trips on, White River, during the fiscal year 1887–'88.

Name.	Where plying.
A. Carey	Hazleton to mouth of White River.
Hugh Barrs (very small boat)	Forks of White River to Decker Station.

C C 6.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The project for the improvement of this river contemplates the formation of a clear channel at least 40 feet in width, with a minimum depth of 2½ feet during eight months of the year, for a distance of 41 miles.

Owing to the very small amount of funds available, about $550, very little work was done during the year, and that consisted of the removal of a number of obstructions, snags, tree-tops, etc., from the first 19 miles of the river.

The river is in good condition to the Fish Trap Ford, a distance of about 24 miles from the mouth, though a few snags are yet to be removed.

Money statement.

July 1, 1887, amount available		$5
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$160.12	
July 1, 1888, outstanding liabilities	18.00	
		1
July 1, 1888, balance available		3
Amount appropriated by act of August 11, 1888		6,0
Amount available for fiscal year ending June 30, 1889		6,3

COMMERCIAL STATISTICS.

Commercial statistics of Tradewater River, Kentucky, for fiscal year ending June 30,

Articles.	Quantity.	Value.	Articles.	Quantity.	V
Coal ..... bushels..	973,580	$58,414.80	Staves ..... number..	273,000	$32
Wheat ..... do....	214,350	150,045.00	Potatoes ..... barrels..	4,730	9
Corn ..... do....	62,374	26,268.30	Hogs ..... head..	3,210	38
Flour ..... barrels..	17,389	86,945.00	Beef cattle ..... do..	732	21
Bran ..... tons..	389	5,835.60	Sheep ..... do...	472	1
Tobacco ..... pounds..	178,480	99,164.00	Eggs ..... dozens..	3,478	
Lumber sawed . feet, B. M..	2,537,475	253,475.00	Poultry ..... do...	973	1
Lumber in logs ..... do...	1,347,534	11,780.27	Miscellaneous freight . lbs..	75,335	87,

APPENDIX D D.

IMPROVEMENT OF GREAT KANAWHA AND ELK RIVERS, AND OF CONSTRUCTION OF HARBOR OF REFUGE AT MOUTH OF GREAT KANAWHA RIVER, WEST VIRGINIA—IMPROVEMENT OF NEW RIVER, IN VIRGINIA AND WEST VIRGINIA.

REPORT OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on the Great Kanawha River, West Virginia.
3. Harbor of refuge at mouth of Great Kanawha River, West Virginia.
4. Elk River, West Virginia.
5. New River, Virginia and West Virginia.

EXAMINATIONS.

6. Gauley River, West Virginia; Meadow River, West Virginia.

(For letter of transmittal, see Appendix I.)

D D 1.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles.

The means are locks and dams. The locks are about 300 by 50 feet. The following table shows the present condition:

No.	Distance from Charleston.	Style of dam.	Remarks.
2	26½ miles above	Fixed	In operation.
3	21 miles above	do	Do.
4	15 miles above	Movable	Do.
5	9 miles above	do	Do.
6	4 miles below	do	Do.

of the operations of the year.

As the improvement of the river has progre
notably the shipment of coal, has greatly incr

The telephone line has been maintained bet
Charleston and the locks, and is used by nigh
found indispensable for the proper oversight a
as well of construction as of maintenance.

A gauge reader has been kept at Kanawh
the Gauley joins the New to form the Gre
another at Hinton, where the Greenbrier em
The compensation of these men is less than
send to the central office daily reports by post
river at their respective stations, and by te
rapid rise. These reports are necessary as wa
fice in Charleston in order that such maneuvers
in time as the height and duration of the freshet

For perfect security a similar station should b
on the Upper Gauley, and perhaps also on the E

Money statement.

July 1, 1887, amount available	
July 1, 1888, amount expended during fiscal year, exclusi outstanding July 1, 1887	
July 1, 1888, balance available	
Amount appropriated by act of August 11, 1888	
Amount available for fiscal year ending June 30, 1889	
Amount (estimated) required for completion of existin	
Amount that can be profitably expended in fiscal year 1890	
Submitted in compliance with requirements of section harbor acts of 1866 and 1867.	

Abstract of proposals for iron-work for Lock No. 2, opened at Charleston, W. Va., at A

Abstract for proposals for furnishing timber for lock gates of Lock No. 2, opened at Charleston, W. Va., July 28, 1887.

[Approximate quantities.]

No.	Name and address of bidders.	Feet B. M.	Bid per M.	Amount.
1	William D. Lewis, Malden, W. Va	62,000	$26	$1,612
2	I. W. Montgomery, Coal Valley, W. Va	62,000	45	2,790

Contract with William D. Lewis.

Abstract of proposals for completing the No. 2 Lock-house, Great Kanawha River, opened at the United States engineer office, Charleston, Kanawha County, W. Va., at noon June 21, 1888.

No.	Names.	Amount.
1	John Gilliland, Charleston, W. Va	$673.00
2	Henry Crawford, Saint Albans, W. Va. (not signed)	650.00
3	David Eagan, Charleston, W. Va	516.00

Contract with David Eagan.

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, Kanawha County, W. Va., July 2, 1888.

COLONEL: I have the honor to submit the following report on the Great Kanawha River improvement for the fiscal year ending June 30, 1888.

LOCK AND DAM NO. 2—STATIONARY DAM (84¼ MILES FROM MOUTH OF RIVER, AND 26¼ MILES ABOVE CHARLESTON).

This work, which carries the slackwater improvement 5¼ miles farther up, or to the foot of Loup Creek Shoal, was completed and put in operation during the year. The first lockage was made December 12, 1887.

THE LOCK.

The contractors for "finishing Lock No. 2," Chas. H. Strong & Son, of Cleveland, Ohio, completed their work early in July. This finished the lock, except the gates. Descriptions of the work embraced by this last contract for the masonry, etc., of the lock, and of the entire structure, have been published in your recent Annual Reports.

THE LOCK-GATES, FILLING VALVES, TRESTLE DAM, ETC., AT NO. 2.

The material for the lock gates was procured by regular contracts; Ainslie, Cochran & Co., of Louisville, furnishing the iron-work, and W. D. Lewis, of Malden, W. Va., the timber. The gates were built and hung by hired labor. The upper set were erected in place on the sills and platform of the head bay; the lower gates were built on the bank, slid on ways into the river, towed into the recesses, and raised by steam capstans and screws.

The lower gates are 31¼ feet high, each leaf weighing, with valves, etc., attached, about 46½ tons. The gates fit and work well and are a nice job throughout. They were built and hung by an average force of about 15 men, mechanics and laborers together, in twelve weeks. The master carpenter on the construction of the gates, Mr. J. S. Williams, deserves much credit for skill and energy shown in building and handling them.

The filling valves, the maneuvering apparatus for valves and gates, and the trestles for the needle dam across the head of the lock were also placed by hired labor.

The dam and abutment rest on solid rock, about 14½ fee

For the greater part of the dam the river-bed material w and the bottom cribs sunk to rock.

For the abutment and 75 feet of the dam next to it and p the excavation was made "by hand," the water being kept the works built "in the dry" on the rock.

The following are the quantities and cost of work done u

Grubbing and clearing, complete	
Excavation, at 75 cents	cubic y
Excavation (rock), at $1.50	d
Embankment, at 35 cents	d
Puddling, at $1	d
Stone filling, at $1.55	d
Hand-placed riprap, at $2.50	d
Paving, at $4	d
Rock-face masonry, at $9.50	d
Coping, at $16	d
Timber, in place, at $30 per M	feet, B.
Iron, in place, at 5 cents per pound	poun
Amount paid contractor	

Banking the dam.—The banking of the dam was not inclu this was commenced with the Government dredge and tow-b and continued until January 3, 1888, when the work was weather and the boats laid up for winter. In connection wi approaches of the lock this season, some additional material dam; this work is now about two-thirds done and will be fin little banking was required to overcome the leakage sufficie ordinary stage, and the water has not been below, or down t cember, 1887.

Lock-house, completion of.—Proposals for completing the unf house at No. 2 were opened here by you on June 21. The c the lowest bidder, Mr. David Eagan, and he is now getting re

Operating Lock and Dam No. 2.—The first lockage was mad work has been in regular operation, except six days during t tion was suspended by ice, since that date.

Riprapping, fitting up grounds, etc.—During the winter and yards of riprap were placed on the banks adjoining the work ment, by the regular lock hands and a few hired [redacted]

The lock is filled or emptied in four minutes. The discharge-valves are in the lower gates; five valves in each leaf.

Lockages are made, either up or down, in from six and one-half to eight minutes.

The No. 2 Pool.—The completion of this lock and dam extends slackwater navigation into, perhaps, all considered, the richest and most extensive coal-fields of the Great Kanawha, and the river shipments of coal and coke from this part of the valley must soon be large. Owing to steep slopes and bad shoals part of the river was practically useless for coal-boat navigation, and up to this time the shipments from there have been almost entirely by rail. Some of the operators have already commenced to ship by river, having got ready, or partly so, in anticipation of the lock and dam, and others are now making preparations to build tipples and procure barges. It is probable that the shipment of coal and coke from the No. 2 Pool will, in a few years, equal or exceed that from any other pool on the river.

The following is taken from the records kept at No. 2:

Through the lock since December 12, 1887:

Coal	bushels..	560,000
Coal barges		116
Steam-boats		888
Total lockages made		881

LOCK NO. 3, STATIONARY DAM (21 MILES ABOVE CHARLESTON).

Navigation was suspended five days during the winter by ice. With this exception the lock has been in regular operation.

Filling valves, leakage of.—The leakage about the filling valves has been getting gradually worse again since the repairs of November, 1886. It is so much now that the lower gates have to be started open against a head of about 7 inches, causing hard work for apparatus and men, and slow locking. It has proved impossible to overcome the leakage of and about these valves, and by your direction plans are now being made to remove them and put in a filling device similar to that at Lock No. 2. This will necessitate entire new valves and maneuvering apparatus and a general remodeling of the platform and timber-work in the head bay. It is proposed to get the materials ready to place, as far as possible, in advance, and do the work some time this fall during low water.

Riprapping, etc.—About 300 cubic yards of riprap were placed on the banks at wearing points about the works, during the year. Some improvement was also made in the approaches to the lock by grading the bank and removing obstructions along the shore.

Emptying valves.—A screw device for maneuvering one of the emptying culvert-valves, was designated, procured, and set last spring.

The following is from the records kept at No. 3 for the year:

Through the lock:

Coal	bushels..	1,215,700
Coal barges		268
Steam-boats		1,747
Other craft		75
Passengers		7,436
Miscellaneous freight, merchandise, produce, etc	tons..	3,276
Lumber	B. M..	741,950
Total number of lockages made		1,786

THE MOVABLE DAMS.

The three completed movable dams with their locks have been in good working order during the year. About the usual amount of expense and labor, the latter in main part done by the regular hands, has been required to keep the works in good condition, but no extensive repairs have been necessary. The following is a brief account of operations at each of the movable dams:

LOCK AND DAM NO. 4 (16 MILES ABOVE CHARLESTON).

The dam has been up 214 days during the year. It was lowered three times and put up twice. It was up at the date of the last Annual Report and remained standing until January 3, 1888, when it was lowered for the winter.

Special reference to this lowering of the dams will be made further on. The dam remained down till May 1, 1888, when the spring raising was begun. It was put up by 5 men in 4 hours. It was closed June 12, 1888, and remained up until the 29th, when it was lowered by 5 men in 2 hours, for a rise, and is still down.

7 men (including some of the dredge crew) between 7 a. m. the 2d. Lowered for a rise, May 13, by 6 men, in 2 hours closed again June 9, and remained up until June 29, 1888. the rise, without any difficulty, and is still down.

The following is from the records kept at the lock during th

Through the lock:			Through the navigatio	
Coal	bushels..	2,429,700	Coal	
Coal-barges		1,103	Coal-barges	
Steamers		1,301	Steam-boats	
Other craft		52	Other craft	
Passengers		10,231	Rain-fall	
Total lockages made		1,462		

LOCK AND DAM NO. 6 (4 MILES BELOW CHARLESTON AND 54 MI OF THE RIVER).

The dam was lowered three times and put up twice during altogether 218 days. When lowered for winter, on January 3, 1 standing, as had also Nos. 4 and 5, since June 16. The spri plished by 4 men, between 5.30 a. m. of May 1, and noon of lowered for the rise of May 13, and remained down till June 9, 4 men in 8½ hours. It was thrown again June 29 (the maneuv in 3 hours), and is still down.

The following is compiled from the records kept at the lock. that navigation in the unslacked watered river below No. 6 w pended for six months during the year, by low water.

		Through the lock.
Coal	bushels..	1,544,000
Coal-barges		600
Steam-boats		461
Other craft		101
Passengers		2,070
Miscellaneous freight, merchandise, produce, etc	tons..	2,194
Railroad ties		10,187
Saw-logs		616
Staves		
Tan bark	cords..	250
Sawed lumber	1,000 feet B. M..	[illegible]
Total lockages made		

and seriously damage many loaded barges. The night of the 29th was still colder, the thermometer falling to +7°, and the pools were frozen over with stout ice from 1 to 2½ inches thick. On the 30th news was received of more moderate weather in the Northwest, and it was decided to hold on to the dams a little longer.

Floating ice was not allowed to accumulate against the bridges and wickets, but kept running over the dams, the pools being kept flush, as necessary, by the use of joint covers.

In the No. 6 or Charleston Pool the ice was kept broken up as much as practicable by tow-boats. No material damage was sustained at any of the works. The river began to rise a little January 2, 1888. The dams were held till the morning of the 3d, when they were all successfully and rapidly lowered.

At No. 4 there was some trouble with the bar gearing and several of the wickets were tripped by hand, but the entire maneuver was made by 4 men in 3 hours. Dams 5 and 6 were put down by 6 men in 3 hours and 10 minutes. In lowering the weir trestles at No. 6 some of the bridge aprons were carried over the wrong way by the current; one of the aprons was twisted off and another considerably bent in this way. One of the pass wickets at this dam also got fouled with the trestle-chain and failed to go clear down, but was afterwards lowered, uninjured.

As stated before, the dams when put down this time had all been standing since June 16, 1887, a continuous period of 201 days.

Owing to the rise in the river, beginning January 2, 1888, the lowering of the dams on the 3d caused no damage to loaded barges. The greater part of coal held in the river went to market in this rise.

DREDGING.

Owing to scarcity of funds the dredge was employed, altogether, only about three months.

Nearly all of this work with the dredge and tow-boat was at No. 2, banking the dam and improving the approaches to the lock, and has been referred to under that head.

In addition to ordinary repairs on the boats a new steel dipper was purchased, and the dredge fitted up with new spuds.

During the year three sunken coal-barges, two in the Charleston Pool and one near Lock 3, that obstructed navigation were removed by the dredge.

OFFICE AND FIELD WORK, ETC.

Locks Nos. 7 and 8.—In accordance with your purpose to begin Locks 7 and 8 as soon as sufficient appropriation is made by Congress, steps are being taken as far as funds at hand will admit to get these works under contract with as little delay as possible after provision is made. The plans and specifications for Lock 7 have been nearly completed. At the site some additional surveys and borings to rock have also been made during the year.

A line of check-levels was run last month from Lock 6 to the site of No. 7, and on down to the proposed site of No. 8, below Raymond City. Drawings for the single lock-house and office proposed at No. 7 have been made.

Finished drawings.—Complete drawings of Lock and Dam No. 6, including details of the iron work, etc., of the movable dam, and drawings of Lock No. 2 have been prepared, and copies of all made for the files of the office of the Chief of Engineers.

Mr. Thomas E. Jeffries, assistant engineer, has been employed during the year on general office and field work. He was engaged for a short time at Louisville as inspector on the contract for the iron-work of the gates, etc., for Lock 2.

Mr. S. B. Miller, civil engineer, has been employed part of the time during the year, mostly on office work.

Mr. Theodore Schoonmaker continued to act as inspector and assistant engineer on construction of Lock and Dam No. 2 until the completion of that work, and has been engaged part of the time since on plans and drawings in this office.

The faithful and efficient services of these gentlemen is gladly acknowledged.

RAILROAD BRIDGE AT POINT PLEASANT.

Under your direction to look after this bridge, building over the Great Kanawha, as regarded its construction in conformity with approved location and law, occasional measurements and examinations of, and reports on, it have been made from this office during the year.

The bridge was built by the Ohio River Railroad Company, and was finished last April. It is a cantalever. The river span is 480 feet long between centers of piers, or about 458 feet in the clear at low water. The shore spans are each 160 feet. The lowest point of the bridge at the center, or of the "suspended span," is 90.37 feet

UNITED STATES EN
Charleston, Kanawha County, W. V

Coal shipped from mines on the Great Kanawha River, below K statistics relating to the coal business for the several

Year.	Shipments by river.	Shipments by railroad.	Total shipments.	Mine operat
	Bushels.	*Bushels.*	*Bushels.*	*No*
1875	4, 048, 300	*5, 792, 925	9, 841, 225	
1876	5, 024, 050	*6, 609, 650	11, 633, 700	
1877	5, 183, 650	*7, 758, 800	12, 942, 450	
Year ending—				
June 30, 1881	9, 628, 696	6, 631, 660	12, 260, 356	
June 1, 1883	15, 370, 458	13, 290, 255	28, 660, 713	
June 1, 1884	18, 421, 084	12, 059, 172	30, 480, 256	
June 1, 1885	17, 812, 323	12, 972, 217	30, 784, 540	
June 1, 1886	17, 861, 613	13, 953, 745	31, 815, 358	
June 1, 1887	23, 233, 374	19, 160, 896	42, 394, 270	
June 1. 1888	20, 100, 625	20, 962, 686	41, 063, 331	

*The shipments by railroad for the first three years given, viz, 1875, 1876, mines above Kanawha Falls.
†Estimated.

The unusually long continuance of low water last season, re Report, will account for the falling off in the shipments by riv ing June 1, 1888. Navigation was almost entirely suspended part of the river for six months of the time. About 18,000,0 shipment for the year went out in the five months between 1888.

Respectfully submitted.

AD

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

In compliance with the proviso to that section which requires the rendition of an itemized statement of such expenses, I have the honor to forward the inclosed paper.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Statement of amount expended during the fiscal year ending June 30, 1888, out of the general appropriation for "operating and care of canals and other works of navigation" in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.

Lock and Dam No. 2, after completion, December 11, 1887:		
For wages of regular lock hands	$1,096.50	
For repairs and extra labor	280.09	
For supplies, as oils, fuel, tools, etc	153.05	
For freights and transportation	5.90	
		$1,535.54
Lock and Dam No. 3:		
For wages of regular lock hands	1,954.99	
For repairs and extra labor	333.03	
For supplies, as oils, fuel, tools, etc	101.90	
For freights and transportation	3.80	
		2,393.72
Lock and Dam No. 4:		
For wages of regular lock hands	1,994.91	
For repairs and extra labor	253.45	
For supplies, as oils, fuel, tools, etc	119.99	
For freights and transportation	4.95	
		2,373.30
Lock and Dam No. 5:		
For wages of regular lock hands	1,987.03	
For repairs and extra labor	306.13	
For supplies, as oils, fuel, tools, etc	55.98	
For freights and transportation	1.00	
		2,350.14
Lock and Dam No. 6:		
For wages of regular lock hands	1,966.01	
For repairs and extra labor	306.25	
For supplies, as oils, fuel, tools, etc	117.46	
For freights and transportation	2.20	
		2,391.92
For part of central office expenses and general superintendence:		
Wages	1,331.00	
Rent and supplies	263.51	
		1,594.51
For dredging at locks and part of running expenses of steamboat:		
Wages	1,442.79	
Repairs	159.05	
Supplies	95.45	
		1,397.29
Telephone:		
For rent of instruments	129.96	
For repairs	93.84	
For freights and transportation	13.40	
		237.20
Gauge-keepers:		
For pay of gauge-keepers and reporters at Hinton and Kanawha Falls		144 00
Total		14,417.62

the said lot to a point in the upper line thereof; thenc
twenty-four degrees thirty minutes east, crossing the cen
twenty-seven feet, in all fifty-four feet; thence south sixty
feet through the said lot to a point in the lower line there
of said lot north twenty-four degrees thirty minutes west,
said railroad at twenty-seven feet, in all fifty-four feet, t
taining about three-fourths of an acre. And the privil
said company of hereafter laying, maintaining, and usin
States property on the north bank of said river at lock
at lock and dam number three, and at lock and dam numbe
however, to the antecedent written consent and approval
location, construction, and width of right of way: *Prov*
Ohio Railroad Company, its successors and assigns, shall
his discretion require it, pay a reasonable yearly rental fo
thereof to be ascertained and prescribed by the Secretary
That the said company shall construct and maintain, at it
crossings, cattle-guards, and fences over and along the l
said Government property, at all of the four lock and d
act, as may be required by the Secretary of War: *Prov*
company shall take up and remove its track or tracks fro
part thereof, at either or all of the four sites mentioned, w
the Secretary of War; and such removal shall not be m
claim for damages against the United States: *And provid*
to repeal, alter, or amend this act is reserved to Congress.

Approved, February 28, 1887.

[PUBLIC—No. 123.]

AN ACT to authorize the construction of bridges across the Great
and to prescribe the dimensions of the sa

Be it enacted by the Senate and House of Representatives of in Congress assembled, That any persons or corporations erect a bridge or bridges across the Great Kanawha River, after erect bridges across said river, for railroad or other the provisions and requirements of this act.

SEC. 2. That every bridge erected across the Great Ka ginia, shall have its axis at right angles to the current its piers parallel to the current, and all of its

drawings of the bridge and piers, and a map of the location, giving, for the space of at least one mile above and one mile below the proposed location, the topography of the banks of the river and the shore-lines at high and low water. This map shall be accompanied by others, drawn to a scale of one inch to two hundred feet, giving, for a space of one-half a mile above the line of the proposed bridge and a quarter of a mile below, an accurate representation of the bottom of the river by contour-lines two feet apart, determined by accurate soundings, and also showing over the whole width of this part of the river the force and direction of the currents at low water and at high towing stages, by triangulated observations on suitable floats. The maps shall also show the locations of other bridges, locks, and dams, coal-tipples, cribs, and all public and private structures in the vicinity inside of high-water lines, and shall give such other information as the Secretary of War may require for a full and satisfactory understanding of the subject. Said maps and drawings shall be referred to a board of engineer officers for examination and report, which board shall personally examine the site of the proposed bridge, and shall hold a public session at some convenient point to hear all objections thereto, of which public session due notice and invitation to be present shall be given to all interested parties; and if said board of engineer officers report that the site is unfavorable, the Secretary of War shall be authorized, on the recommendation of said board, to order such changes in the bridge or its piers, or such guiding-dikes or other auxiliary works, as may be necessary for the security of navigation; and such changes or additions shall be made at the expense of the owners of said bridge; and the proposed bridge shall only be a legal structure when built as approved by the Secretary of War.

SEC. 4. That all parties owning, occupying, or operating bridges over the Great Kanawha River shall maintain, for the security of navigation, at their own expense, from sunset to sunrise, throughout the year, such lights on their bridges as may be required by the Light-House Board or the United States engineer officer in charge of said river; and during the construction of any bridge under this act, such lights and buoys shall be kept on coffer-dams, cribs, piles of stone, floating crafts, rafts, and so forth, used in the construction of the bridge, as may be necessary for the security of navigation.

SEC. 5. That the officers and crews of all vessels, boats, or rafts navigating the Great Kanawha River are required to regulate the use of the said vessels, and of any pipes or chimneys belonging thereto, so as not to interfere with the construction of any of the bridges authorized by the provisions of this act.

SEC. 6. That any bridge constructed under this act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to the said bridge; and the United States shall have the right of way for telegraph or telephone purposes across any such bridge; and in case of any litigation arising from any alleged obstruction to the navigation of said Great Kanawha River created by the construction of any bridge under this act, the cause or question arising may be tried before the circuit or district court of the United States for the district of West Virginia.

SEC. 7. That the right to alter, amend, or repeal this act so as to prevent or remove all material obstructions to the navigation of said river by the future construction of bridges is hereby expressly reserved, without any liability of the Government for damages on account of the alteration or amendment of this act, or on account of the prevention or requiring the removal of any such obstructions; and any change in the construction or any alteration of any such bridge that may be directed at any time by Congress shall be made at the cost and expense of the owners thereof.

Approved, March 3, 1887.

D D 3.

HARBOR OF REFUGE AT MOUTH OF GREAT KANAWHA RIVER, WEST VIRGINIA.

No work has been done on the ice-piers during fiscal year.

Money statement.

July 1, 1887, amount available	$168.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	168.44

July 1, 1888, balance available.....
Amount appropriated by act of August 11, 1888.....

Amount available for fiscal year ending June 30, 1889....

Amount (estimated) required for completion of existing
Amount that can be profitably expended in fiscal year endi
Submitted in compliance with requirements of section
harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

UNITED STATES I
Charleston (Kanawha)

COLONEL: I have the honor to submit the following stat
River during the year ending June 30, 1888. This informa
since the receipt of your instructions of June 28.

Lumber, etc., which came down Elk River to or past Ch
ing the year:

Lumber and logs.....1,00
Railroad-ties .....
Hoop-poles .....
Oak staves .....

As near as can be ascertained, the value of merchandise
city during the year, and taken up Elk River mostly in pus
about $350,000.

Very respectfully, your obedient servant,

A

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1887, amount available	$10,222.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	75.00
July 1, 1888, balance available	10,147.29
Amount (estimated) required for completion of existing project	159,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

D D 6.

PRELIMINARY EXAMINATIONS OF GAULEY AND MEADOW RIVERS, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., December 26, 1887.

GENERAL: I have the honor to submit the following report of the examination of Gauley and Meadow rivers, West Virginia, called for by Congress in the last river and harbor bill which became a law.

After much search for information concerning those streams, by means of correspondence with residents of the section through which they flow, as well as with others familiar with them or interested in their improvement, and after study of existing maps and documents, printed and manuscript, I made an examination of the lower 10 miles of the Gauley in the early part of June, 1887. As I was obliged then to return to Baltimore, the examination was continued and completed by Col. W. Proctor Smith, lately of the Corps of United States Topographical Engineers.

A copy of the report of Colonel Smith, dated July 18, 1887, is herewith, in which he gives a full description of the Gauley and Meadow rivers, their physical characteristics, capability for improvement, character of products of the regions through which they flow, etc. These things need not be again gone over by me.

The "Roughs" of the Gauley, commencing 12 miles from the mouth and extending for a distance of 26 miles, may be deemed an insuperable barrier to open navigation by boats for the Gauley at and above them, and for its tributaries above them, including Meadow River, except at a very great cost, out of proportion to any advantage likely to be gained by such an improvement in the present condition of the country.

The Gauley as high up as the foot of the "Roughs" is already navigable for bateaux carrying 8 to 10 tons, but the navigation is difficult. It is, however, important to the people living along or near this stretch, for by it they are enabled to communicate with the pool of the Great Kanawha River just below the mouth of the Gauley, along which runs the trunk line called the Newport News and Mississippi Valley Railroad. A valuable improvement of these 12 miles of the Gauley could be made at an expense of $10,000.

While no estimate is submitted for a boat navigation of any other part of the Gauley or for the Meadow River, it is considered proper to call attention to the great advantage which would follow the expenditure of $65,000 in the "Roughs" *in facilitating* and cheapening the bring-

at the falls, a short distance below the mouth would cost $700,000, it may seem expedient to up the Gauley some distance to facilitate the n the great bodies of fine coal now undeveloped n this point a report, with estimate, is appende under date of May 23, 1887.

It is understood that surveys for a railroad u made, and in connection with this scheme the p Kanawha and Ohio Railroad above Charleston i

The country through which Meadow River fl from its relations to the project for the improve awha River set forth by the distinguished engi in his report of 1858, which contains much valu

Those who would wish for detailed informati this region are also referred to the volume entit Virginia," prepared in 1876 under a State board

Two maps are herewith, the first showing in awha and its tributaries, of which the Gauley i other* being a sketch of Lower Gauley, prepare company his report already referred to.

No detailed survey of the Gauley and Meadow time. The improvement of the rivers is recom dicated in the foregoing report, viz:

For bateaux navigation, Lower Gauley .....
To facilitate movement of lumber in Gauley .....

To facilitate movement of lumber in Meadow.....

Very respectfully, your obedient servant
W

The CHIEF OF ENGINEERS, U. S. A.

The Gauley has a width, at its junction with the New River (or Kanawha), of 500 feet and a depth of 5 or 6 feet at "low water." At about 1 mile from its mouth it narrows to about 300 feet, and maintains nearly the same for 10 miles (above its mouth).

It has a fall in this distance of about 40 feet, or 4 feet per mile, and flows over a rocky bed (of sand conglomerate) in shallow rapids and deeper pools, the latter averaging about 1 mile in length each.

The banks are high and rocky, in fact, are generally the foot-slopes of the mountains; the tributary creeks rise much more rapidly than the river, and have no valleys low enough to be injured by backwater from the dams even in freshets.

The mountains on either side are filled with beds of excellent coal, and iron ore of good quality is said also to be abundant. The upper parts of the river, as well as of all its tributaries, are heavily timbered with walnut, oak, and poplar, in which quite a heavy trade is even now carried on, though I have been unable to obtain statistics on this subject.

In order to carry a 7-foot slackwater navigation from below Kanawha Falls up the Gauley 10 miles (to a point 1 mile above Little Elk Creek) I have adopted the dam and lock system planned for the New River (or Kanawha) in 1874–'76, viz: A flight of two locks each of 15 feet lift, with a connecting basin 250 feet long, and a dam 13 feet high, located about 1,500 feet above crest of falls (measured on center line of river) and 7,200 feet below the mouth of the Gauley.

This dam would raise the water 3 feet above its present level at mouth of Gauley and back it to the shoal at Scrabble Creek, 1 mile above the mouth. It is proposed thence above to place four dams averaging 15 feet in height (to foundations), with a 10-foot lift-lock in each of same size as designed for New River, viz, 250 feet by 40 feet in the chamber. The dams would average about 250 feet in length, exclusive of guard-banks, etc. Assuming the same details as were used in projects of 1874–'76 for New River, the cost would be as below:

Two locks 15 feet lift, and dam 1,400 feet long, at Kanawha Falls	$299,000
Four locks 10 feet lift, and four dams 250 feet long, each $120,000	480,000
Making a total of	779,000

The present timber interest would be satisfied with a dam and boom piers near the mouth of Gauley, which could be done for about $50,000.

A small sketch* is submitted, taken from plat of the "Maury" land grant, which shows streams only on one side of the river, the one followed by the road and having the largest drainage area. There are no long tributaries on the left bank, owing to the short drainage area on that side. No better map has been obtainable, and neither time nor money was available to construct one.

Respectfully, yours,

N. H. HUTTON,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers U. S. A.

REPORT OF MR. WILLIAM PROCTOR SMITH.

BALTIMORE, MD., *July* 18, 1887.

COLONEL: After a minute examination of the papers in your office relating to the Gauley and Meadow rivers, in West Virginia, in accordance with your verbal instructions I went to Kanawha Falls, W. Va., May 31, where I made some preliminary investigations and then proceeded to examine the Gauley River from its mouth to its forks, near its source, as well as Meadow River from its source to its mouth, making estimates on each stream as to cost of improvement for "floating" logs, and also for a bateau channel on the lower 12 miles of the Gauley, after which I returned to Kanawha Falls and thence to Baltimore, Md., having been gone about four weeks.

During the first week, in company with yourself, I made some investigations of the lower 10 miles of the Gauley, and also a trip to Charleston, W. Va., in connection with the same. The trip was made on horseback over the main roads and bridle-paths, going into the rivers at all accessible points, making examinations above and below for some distance on foot. To be more exact, I went from Kanawha Falls to the mouth of Gauley River; thence to Little Elk Creek; Nicholas Court-House; Webster Court-House; Forks of Gauley; mouth of Williams River, up the same to its forks and

*Omitted.

sometimes nearly west, and near its mouth almost due south
to the State of West Virginia. Its headwaters and those of it
with a virgin forest of the finest of timber, with only a cle
and there; and on the north side of the river, in Webster and
glades a few miles wide and in extent 20 or 25 miles, which giv
to break up this vast timber section.

For the first 12 miles from its mouth the Gauley falls only
next 26 miles its fall is nearly 34 feet per mile, in a gorge simi
as seen from the Chesapeake and Ohio Railway between Kan
the hills on either side being several hundred feet high and al
streams full of bowlders of sandstone, some very large, and s
the people in calling this section the "Roughs" of Gauley.
"Roughs," near Hominy Creek, 2 miles above Hughes Ferry,
miles, the fall is estimated at 5 feet per mile. The levels fro
River to the mouth of Meadow River, 29 miles, are taken fro
Great Kanawha River, West Virginia, made in 1858; the re
The levels on Meadow River were obtained from the same sou

Gauley River is 500 feet wide at its mouth, 350 feet wide
River, 200 feet wide at mouth of Cranberry River, 150 feet wid
River, and 75 feet wide at the Forks.

As the main object of the present examination was to asc
these rivers for the purpose of "floating" logs, it will readily
est obstructions to that method of getting out timber must o
the "Roughs," and such is the case, the worst places being fo
Shoal, the third encountered in going up the "Roughs;" seco
below Carnifex Ferry; and third, the Big Chute, 1¼ miles bel
many places where there are islands, when the river is up (and
reported, 40 feet), the logs take the false channels round the is
in by the bowlders at the lower end, and there is no way to ge
edy for this must either consist in running shears from the mai
the island or in blasting out the rock at the foot of the same.

The principal work, as mentioned before, is found in the "
mate has been made for blasting out the rock, leaving the piec
by the action of ice and freshets into deep water and thus ma

For such a channel 30 feet wide, and to round off the angles,
to the head of the "Roughs," 26 miles, will cost about $2,25
From the head of the "Roughs" to Stroud's Creek, 25 miles, w
$200 per mile .....
From Stroud's Creek to Forks of Gauley River, 32 miles, will c

Total

The channel to be 30 feet wide and 2 feet deep. The first estimate is for ordinary summer water and the second for extreme low water, regarded as 1 foot lower than ordinary summer water.

There is a small dam 5 or 6 miles below the Forks of Gauley, and another, for a corn and flour mill, a mile or two above the mouth of Williams River; but as the river has always to be up several feet before logs can be floated, these dams are not regarded as much of an obstruction by timber-men.

The Gauley and its tributaries, including Meadow River, drain an area of about 2,500 square miles.

Williams River, rising in the Greenbrier or Yew Mountains, is about 35 miles in length, and averages about 100 feet wide up to its forks (9 miles). It empties into the Gauley 75 miles above its mouth, and is a larger stream than its principal. No difficulty in floating logs on its waters. With the exception of half a dozen clearings of a few acres, the country it drains is covered with the finest of timber, including the extensive yew forests at its head.

Cranberry River also rises in the Greenbrier on Yew Mountains, and is from 20 to 25 miles long and 150 feet wide at its mouth. It flows into the Gauley 60 miles above its mouth. It has as fine and as much timber as Williams, which can be got out as easily, if not more so, than on that stream. There is scarcely a settlement on it. It is named from the cranberry glades at its source.

Cherry River rises in Cold Knob, is about the same length and size as Cranberry, 150 feet wide at its mouth, and flows into the Gauley 57 miles from its mouth. The "divide" between Cranberry and Cherry rivers is covered with timber and is very wild. From a point 9 miles up from the Gauley, for 28 miles into Pocahontas County, no house is encountered. On the upper waters of Cherry some farms and grazing lands have been opened up. It gets its name from the great number of large cherry trees on its banks and throughout the country it drains.

Williams, Cranberry, and Cherry rivers flow in a northwesterly direction and enter the Gauley on its left bank.

Muddlety Creek, rising in the "divide" between Gauley and Elk rivers, joins the Gauley on its right bank 42 miles above its mouth. Some timber on it, but it is principally cultivated. The best lands in Nicholas County are found along its banks and those of its small tributaries.

Hominy Creek is short and very rough, but has plenty of timber. It flows into the Gauley from the south, 39 miles from its mouth.

Peters, Laurel, Little Elk, and Twenty-Mile creeks, flowing into the Gauley on the right bank and Rich Creek from the left, all being below the mouth of Meadow River, 29 miles above the mouth of Gauley River, drain about all the territory on which it is claimed there are to be found iron ores, and certainly the largest amount, greatest variety, and best quality of the coal. In fact, all of the New River and Kanawha seams are found here, cannel, splint, and bituminous, estimated at 60 feet in all veins, from 3 feet to 11 feet in thickness. All the hard and soft varieties are here, and the cannel in places is claimed to be 11 feet thick. Nothing but horizontal mining is required, which does away with shafts and avoids trouble with water.

Eight seams of red hematite iron ore, aggregating 17 feet, are said to be found in the above section of country in veins from 1 foot 6 inches to 4 feet, and Black Band ore from 12 inches to 18 inches, and that the former will yield 65 per cent. of iron, also gray limestone and fire-clay. A vein of coal runs up the Gauley River above the section described. It is 5 feet thick at the mouth of Cherry River, low down near the bed of the river, and about 3 feet thick at Stroud's Glades further up. This vein continues all the way to the head of the Gauley, and is found opposite the mouth of Williams River, at Nicholas Court-House, and again near Webster Court-House. The Greenbrier or Yew Mountains contain the Sewell vein of coal, from 3½ feet to 6 feet thick.

There is timber on both sides of the Gauley River, but the larger portion is on the south. Williams Cranberry, and Cherry rivers, as before stated, abound in timber, poplar, white oak, cherry, curly and bird's-eye maple, ash, hickory, buckeye, locust, walnut, chestnut, gum, sycamore, beech, hemlock, yellow lynn, and sugar trees. At the headwaters of the Gauley and these tributaries are found almost impenetrable forests of the yew pine. The poplar, ash, cherry, and white oak are very fine, also large Spanish oaks, a species of red oak. Many acres from these timber regions will cut 20,000 feet of lumber and some 40,000 feet. Walnuts are found 5 feet in diameter, poplar 18 feet in circumference and 80 feet to the limbs, some said to be even larger. Ash trees, 8 feet, 9 feet, and 10 feet in circumference, and 50 feet long, will yield from 2,000 feet to 4,000 feet of inch lumber. Fine place for getting railroad ties and tan bark and to make paper pulp. In fact, this section, for its extent, is thought to be the finest timber and coal region in the United States, and being so well watered it has more than the usual facilities for mining coal and iron and getting out lumber.

The climate is mild. Temperature in summer from 75 degrees to 85 degrees, in

winter seldom lower than 20 degrees below freezing point, but there is more snow than is usually found in other parts of the State.

This region produces corn, oats, wheat, rye, tobacco, hay, and potatoes. The land is moderately productive, all sandstone formation. The grain is not shipped to market, from 30 to 60 miles haul in wagons being too far to make such shipment profitable. Sheep, horses, and stock cattle are raised to a considerable extent and a good deal of wool is exported.

Nicholas Court-House has three stores and a population of about 100. There are twenty-six stores in the county, with average sales for each of about $2,000 per annum. Population of county 8,500 souls. Stock cattle, horses, and sheep are raised, of which the sales last year amounted to $75,000. Only enough breadstuffs and rough feed raised to supply the wants of the people and stock.

Pocahontas County, in this section, is not under cultivation, the whole of it being covered with timber.

Webster Court-House has a population of 140, and a fine salt-sulphur spring, the visitors to which are increasing every year. The county contains 4,500 souls, and nine stores, with average sales for each of $1,500 per year. Sales of stock for the same period, $35,000.

The commerce of Greenbrier, in the meadows section, is given in the report on Meadow River. Although a part of Fayette County lies on the Gauley and Meadow rivers, all of its products are carried to New River and the Chesapeake and Ohio Railway, as the distance is short.

The cash value of whatever is raised on these rivers is represented by the sales of the stores, for everything produced, except the stock, is traded to the merchants for goods.

From Little Elk Creek and up as far as the foot of the "Roughs" on Gauley, we shipped last year 20,000 staves of all kinds and 100,000 more from the vicinity Twenty-Mile Creek. Two million five hundred thousand feet of timber, in logs, we shipped out of Gauley River last year, and as many more feet lost, owing to the obstructions and lack of boomage at the mouth of the river.

About 300,000 feet of sawed cherry lumber was hauled from the upper waters Cherry River last year, in wagons, 45 miles, to Ronceverte, a station on the Chesapeake and Ohio Railway, in Greenbrier County, W. Va.

Meadow River, the principal tributary of Gauley River, is about 50 miles length, rising in Keeney's Knobs, Greenbrier County, W. Va., and flows in a northwesterly direction. It falls considerably for the first few miles, but in the next 10 or 12 miles it flows through what are termed the "Meadows," and is almost level. These meadows are extensive glades, from 500 feet to 2 miles in width, producing only hazel, alder, and weeds. Not easy to drain, as there is scarcely any fall in them; but should the channel at their foot be cut out sufficiently wide and deep to allow the river to flow freely, a great deal of land, now practically worthless, could be redeemed and made valuable.

Twenty-eight miles above its mouth, which is 29 miles above the mouth of Gauley River, Meadow River begins to fall rapidly and is very rough; the fall in this 28 miles is 1,199 feet, or at the rate of nearly 43 feet per mile, and even this does not show the entire rapidity, for this fall is nearly all in 23½ miles, as the water from Bracken's Creek to within a mile of Augling's Creek, 4½ miles, is nearly level or free from rock.

From the point at which the river begins to fall so rapidly (that is, where Big Sewell and Laurel mountains approach each other) to the mouth of Big Clear Creek, 6 miles, there is only a fall of about 1½ feet per mile. In this distance Mill, Laurel, and Big Sewell creeks flow into the river. Little Clear Creek, a pretty stream, joins the river 2½ miles above the mouth of Big Clear Creek; the latter is the principal tributary, or rather the real continuation, of Meadow River, for it affords more water than the stream which is now dignified with the name of river.

Big Clear Creek rises in Cold Knobs, Greenbrier County, W. Va., and runs in a northerly direction. It is about 15 miles in length and 110 feet wide at its mouth, the width of Meadow River at this point being about the same.

To improve this creek for floating logs for 10 miles, which is all that is needed, will cost about $100 per mile; in all, $1,000.

The rapid portion of Meadow River is the dividing line between Fayette and Nicholas counties; the average width in this distance, 28 miles, is about 125 feet; at its mouth it is 140 feet wide. It flows over a bed of rock usually, and for a great part of the distance is filled with loose sand rock of the same nature as the bottom of the river.

There is one saw-mill 10 miles, and one corn and flour mill 3 miles, above the mouth of this creek.

Thirteen miles above the mouth of Meadow River, near Russellville, is a worn-out corn-mill; 3 miles above the mouth is a saw-mill and general manufacturing company, and 1½ miles above the mouth is a good corn and flour mill. There is also a corn and flour mill between Augling's and Arrowroot's creeks.

Estimate for improving Meadow River for the purpose of floating logs:

Two miles above the mouth of Big Clear Creek, two places, one-half mile apart, to cut channel through bastard limestone, 30 feet wide and 3 feet deep, 550 cubic yards, at $3 per yard	$1,650
At mouth of Mill Creek, 2 miles below mouth of Big Clear Creek, channel to be made through a shoal of loose rock, 30 feet wide and 2 feet deep, 350 cubic yards, at $1 per yard	350
From 1 mile above Meadow Creek to Cook's Mill, at Bracken's Creek, 14¼ miles, and from 1 mile above Angling's Creek to the mouth of Meadow River, 9 miles, in all 23¼ miles, will cost $1,600 per mile	37,600
Ten miles, Big Clear Creek, at $100 per mile	1,000
Total	40,600

Channel to be 30 feet wide; the rock to be blasted into pieces small enough to allow the ice and freshets to move them into deep water.

Owing to the rapid current, Meadow River does not rise so high as the Gauley; say about one-half so high, or 20 feet.

Owing to the roughness of the Gauley and Meadow rivers, and to the fact that the examination could not be made with a boat, the estimates submitted must be regarded as only rough approximates, but sufficiently near the truth to give a general idea of the amount that will be required to put them in good shape for floating logs.

The Sewell vein of bituminous coal, as it is called, is found in Big Sewell, Little Sewell, Laurel, Big Clear Creek, and Greenbrier or Yew Mountains, extending to the headwaters of Gauley and Elk rivers. This vein is from 3½ feet to 6 feet in thickness, and is a good coke and grate coal.

Both sides of Meadow River are finely timbered with poplar, white oak, ash, hickory, locust, yellow lynn, and sugar. The mountain belts are peculiarly adapted to grazing, and blue grass is indigenous where the timber is cleared away. Timothy is grown considerably in the meadows. Fine fruit is raised. Climate is good from May to November. Abundance of snow. Maple sugar is made to a large extent.

The section along the lower part of the river is cultivated somewhat, but not highly. Oats, corn, wheat, and potatoes are raised, but only in sufficient quantities for the use of the people and stock cattle; none shipped to market.

There are three stores in this section, the average sales of which per year are about $2,000.

Last year 750,000 feet of lumber in logs were floated out of this part of the stream—say, from the mouth 5 miles up.

The Greenbrier or Meadows section supports six stores, whose average sales per year each are about $2,500. All of the small grains are raised here, together with horses, sheep, and fat cattle. This is also a fine fruit and sugar region. Plenty of blue grass and timothy. One thousand five hundred sheep were sold last year at $2 per head and 1,000 cattle at $35 per head. No grain is shipped to market, it being the policy of these graziers to put everything into stock.

Last year about 200,000 feet of sawed cherry lumber were hauled in wagons 30 miles to Alderson, a station on the Chesapeake and Ohio Railway in Monroe County, W. Va.

Respectfully submitted.

WM. PROCTOR SMITH.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

APPENDIX EE.

IMPROVEMENT OF KENTUCKY RIVER; OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON THE KENTUCKY RIVER, KENTUCKY; IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY, AND OF GUYANDOTTE, LITTLE KANAWHA, AND BUCKHANNON RIVERS, WEST VIRGINIA.

REPORT OF CAPTAIN D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Kentucky River, Kentucky.
2. Operating and keeping in repair locks and dams on the Kentucky River, Kentucky.
3. Big Sandy River, West Virginia and Kentucky.
4. Guyandotte River, West Virginia.
5. Little Kanawha River, West Virginia.
6. Buckhannon River, West Virginia.

EXAMINATIONS AND SURVEYS.

7. Louisa [Levisa] Fork of Sandy River, Virginia.
8. Salt River, Kentucky.

UNITED STATES ENGINEER OFFICE,
Cincinnati, July 18, 1888.

SIR: I have the honor to transmit herewith the annual reports on the works under my charge at the close of the fiscal year ending June 30, 1888.

First Lieut. William L. Sibert, Corps of Engineers, has been on duty under direction of this office since April 5, 1888.

Until April 13, 1888, the Big Sandy, Little Kanawha, Buckhannon, and Guyandotte rivers were under the charge of Lieut. Col. William E. Merrill, Corps of Engineers; and the Kentucky River, and operating and care of locks and dams on same until April 17, 1888, were under the charge of Maj. Amos Stickney, Corps of Engineers.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

E E 1.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

This work was under the temporary charge of Maj. Amos Stickne Corps of Engineers, until April 17, 1888, when it was transferred to m charge.

The Kentucky River is a tributary of the Ohio, and empties into it Carrollton, Ky., about midway between Cincinnati, Ohio, and Loui ville, Ky.

The present project for the improvement of this stream was adopte in 1879, the object being to repair the five locks and dams built by th State of Kentucky, and extend slackwater navigation for a draught 6 feet, by the construction of additional locks and dams, to Beattyvill a distance of 261 miles from the mouth of the river.

WORK DONE DURING THE YEAR.

Lock No. 6.—Under date of June 9, 1887, a contract was entered int with O'Brien & Co. to furnish the different classes of stone require for the construction of this lock. By its own terms the contract expire August 31, 1888. Under date of August 15, 1887, an agreement wa entered into between the United States engineer officer in charge an O'Brien & Co., by the terms of which the latter, in consideration of ce tain work to be done by them, were granted the privilege of quarryin stone on the Government land adjacent to the site of the proposed loc but only for the purpose of obtaining stone for this particular lock.

The contractors commenced work some time in July, 1887, and in Oc tober delivered 229.50 cubic yards of backing stone. From that tim on the work progressed very slowly, and on March 2, 1888, the engi neer officer in charge recommended that article 41 of the specification be carried out. Up to this time the contractors had in five months commencing with October, delivered 915.14 cubic yards of backin stone, and at this rate there was every probability of the work of act ually constructing the lock being delayed, the recommendation of th officer in charge was disapproved by the Chief of Engineers. Up t the end of the fiscal year the contractors have delivered stone as fol lows: 2,652.69 cubic yards backing stone; 87.42 cubic yards cut stone quarry face; 48.01 cubic yards squared stone; 6.48 cubic yards cu stone, dressed face; and 76 cubic yards special stone.

The stone to be delivered to complete the contract is as follows 3,455.31 cubic yards backing stone; 1,399.58 cubic yards cut stone quarry face; 1,311.99 cubic yards squared stone; 1,693.52 cubic yard cut stone, dressed face; and 251.24 cubic yards special stones.

The contract can not be completed in the time it has yet to run.

LOCK AND DAM AT BEATTYVILLE.

The Board of Engineers that had previously considered the subjec of the dam at Beattyville having recommended that a rapid-acting loc be substituted for the chutes originally built, and this recommendatio having been approved by the Chief of Engineers and Secretary of Wa proposals for furnishing a portion of the stone for this lock were invite by the usual public advertisement, and opened at the United States en gineer office, Louisville, Ky., March 3, 1888, by Maj. Amos Stickne Corps of Engineers. The only bid received was rejected as being to high, and upon Major Stickney's recommendation authority was given t procure the stone by hired labor. In accordance with this authority a location for a quarry was selected about March 20, and preparation

for commencing the work made. The site of the quarry is about 4 miles below Beattyville, and the price for stone obtained at the quarry agreed upon is 10 cents per cubic yard measured in the lock.

The principal part of the necessary plant for quarrying did not reach the locality until about the middle of April, owing to low water, and at present all freight to the work has to be transported in push-boats for a distance of 80 miles.

The work done to the end of the fiscal year in the way of quarrying and drilling stone is as follows: Dimension stone, 1,305 cubic yards; dressed stone, face stone, 195 cubic yards; squared stone, 75 cubic yards; backing stone, 50 cubic yards.

The progress already made under circumstances far from favorable, appear to warrant the belief that rapid delivery of the different classes of stone to be used in the construction of the lock may be expected in the future.

At Beattyville the old dam has been cut down and floored over, the material removed being utilized in constructing auxiliary works about the abutments, etc., such as retaining and bank protection walls. The new dam, when built, will have for a foundation the part of the old dam now standing, using the abutment now in place on Beattyville side of the river.

During the coming year it is proposed to complete as far as possible Lock No. 6 and the one at Beattyville, besides doing what may be posible towards the construction of what will be known as Lock No. 7 and those immediately above it.

As the people on the Upper Kentucky are for a portion of each year entire dependent upon the river to obtain supplies, and ship and receive whatever freight there may be, owing to the utter lack of roads that can be used for these purposes, it would appear advisable to make such improvements between Ford and Beattyville as may be necessary to insure the low-water navigation of that portion of the river.

For details concerning the work at Beattyville attention is respectively invited to the accompanying report of Assistant Engineer R. S. Burnett.

SNAG-BOAT KENTUCKY.

In consequence of the age of the boilers, a lower steam-pressure was allowed at the last inspection than formerly, so that it became necessary to put in new cylinders. Wider buckets were put on the wheel in place of the old ones. Various other repairs were made to the machinery and, in addition, slight repairs to hull were necessary.

During the year she removed 73 snags from the river, and run a distance of 2,286 miles. Most of the season she was engaged on the lower river, acting as tender to the dredge, towing stone barges, and was a great advantage during the repairs at the various locks.

Money statement.

July 1, 1887, amount available		$158,367.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$54,622.66	
July 1, 1888, outstanding liabilities	7,623.90	
July 1, 1888, amount covered by existing contracts	71,536.55	
		133,783.11
July 1, 1888, balance available		24,584.26
Amount appropriated by act of August 11, 1888		180,000.00
Amount available for fiscal year ending June 30, 1889		204,584.26

Amount (estimated) required for completion of existing project	$1,854,13
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing stone for lock at Beattyville, Ky. Approximate am required 4,601 cubic yards.

No.	Name of bidder.	Cut stone, dressed face.		Cut stone, quarry face.		Squared stone.		To co
		Quantity.	Price.	Quantity.	Price.	Quantity.	Price.	
		Cu. yds.	*Per cu. yd.*	*Cu. yds.*	*Per cu. yd.*	*Cu. yds.*	*Per cu. yd.*	
1	Wendell R. Curtis	1,800	$16.93	1,500	$14.45	1,301	$11.93	$67,0

Proposal opened at Louisville, Ky., March 3, 1888, by Maj. Amos Stickney, Corp Engineers, and rejected as being too exorbitant.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 188

CAPTAIN: I respectfully submit the following report on the improvement of Kentucky River, for the fiscal year ending June 30, 1888:

LOCK NO. 6.

The work of furnishing the several classes of stone for this lock by the contracto O'Brien & Co., has progressed very slowly and unsatisfactorily. Their contract w dated June 9, 1887, and the following is a detailed statement of the stone accep up to the end of the fiscal year:

Date.	Character of stone.	Quant
		Cu. y
October, 1887	Backing	22
November, 1887	do	16
December, 1887	do	12
January, 1888	do	8
February, 1888	do	31
March, 1888	do	48
April, 1888	do	61
May, 1888	do	51
Do	Quarry face	2
Do	Square face	M
Do	Dressed face	
June, 1888	Backing	13
Do	Quarry face	6
Do	Square	3
Do	Special	
Do	Dressed face	1

The contractors will not be able to complete their contract by the time of its piration, August 31, 1888, and this has been due to bad management.

A survey of the location of this lock has been made by J. H. Westerfield, assist engineer.

BEATTYVILLE DAM.

Complying with instructions from Lieut. W. L. Sibert, work was commenced S tember 1 to place this dam and chutes in such a condition as not to interfere with free navigation of the river until the completion of the proposed lock. The crest and t upper steps of the dam were removed and the timber stored on the Beattyville ba the stone being used in protection work on the bank below the dam. All those p tions of the guide-walls and floors of the passes that were considered dangerous w removed.

A channel, 100 feet wide and 350 feet long, was cut through the high bar formed immediately below the chutes. The material excavated was used as bank protection.

A protection wall 378 feet in length, 12 feet wide and 12½ feet high was constructed along the foot of the Proctor bank below the passes. This bank had been washing away very fast during the freshets, but the construction of this wall has stopped it entirely.

The material used in its construction was old material taken from the guide-walls.

A retaining-wall was built in front of lock-house to prevent its slipping into the river; this was also constructed of old material taken from the guide-walls.

The work was not damaged any during the past season and craft passed in safety.

The following is a detailed statement of the work done:

Statement of work done on Beattyville Dam from June 30, 1887, to January 1, 1888.

Dam:

Material removed in leveling the dam to level of second step, viz:

Hewed timber	lin. ft.	12,005
Sawed lumber	ft., B. M.	41,325
Stone riprap	cub. yds.	3,386.5
Spikes, assorted	pounds	10,313
Gravel	cub. yds.	655
Fish-plates		38

Outside guide-wall:

Material removed from lower end, viz:

Hewed timber	lin. ft.	6,299
Stone riprap	cub. yds.	1,126
Sawed lumber	ft., B. M.	16,829
Spikes	pounds	3,309

Side guide-wall:

Material removed from lower end of wall, viz:

Hewed timber	lin. ft.	7,646
Sawed lumber	ft., B. M.	6,998
Stone riprap	cub. yds.	966
Spikes, assorted	pounds	3,944

Middle guide-wall:

Material removed from lower end of wall, viz:

Hewed timber	lin. ft.	7,188
Sawed lumber	ft., B. M.	19,701
Stone riprap	cub. yds.	639
Spikes, assorted	pounds	3,533

Passes:

Material removed, viz:

Flooring	ft., B. M.	47,859
Hewed timber	lin. ft.	851
Spikes	pounds	1,125

Meeting dam at level of the second step:

Sawed lumber	ft. B. M.	38,873
Spikes, assorted	pounds	8,719

CONSTRUCTING PROTECTION-WALL ALONG THE PROCTOR BANK, BELOW THE "PASSES," LENGTH 378 FEET, 12½ FEET HIGH, 12 FEET WIDE.

Material removed:

Gravel	cubic yards	876

Material expended in wall:

Hewed timber	lin. feet	12,296
Sawed timber	ft., B. M.	5,494
Stone riprap	cub. yds.	1,632
Spikes, assorted	pounds	1,932
Gravel backing	cub. yds.	875

CONSTRUCTING PROTECTION-WALL IN FRONT OF LOCK-HOUSE ON THE PROCTOR BANK.

Material removed:

Earth	cub. yds.	107

Material expended:

Hewed timber	lin. feet	679
Sawed lumber	ft. B. M.	7,160
Stone riprap	cub. yds.	275
Spikes, assorted	pounds	1,281

Bar, below asses:

Bowlders and gravel excavated and removed	cub. yds.	4,042.5

GATES.

The gates were raised, the recesses cleaned out and filled with riprap stone; were then fastened down.

NEW STONE LOCK.

On March 20 I was directed by Lieut. William L. Sibert to select the most a ble site for the opening of a limestone quarry, for getting out the necessary sto the proposed lock at once.

The nearest limestone to Beattyville was found on the bank of the Kentucky I below Contrary Creek, 4 miles below the site of the dam.

Arrangements were made with the persons owning the rock for its purchase a a lease of about 5 acres of the only suitable land for a cutting and storage yar uated about one-third of a mile above the quarry.

Work was commenced at once stripping the quarry, constructing the nece buildings for the accommodation of employés, and grading and laying track quarry to stone yard.

The necessary plant was purchased, and as it could only be delivered by wat were delayed in getting it up the river on account of the unusual stage of low until about the middle of April.

Stone cutting was commenced May 17. The quarry develops the finest bui stone yet found on the Kentucky River.

The following is a statement of the work done up to the end of the fiscal year

	Feet.
Built 1 mess-house	70 by 24
Built 2 mess-houses	50 by 24
Built 1 tool-house	35 by 20
Built 1 office	40 by 16
Built 2 out-houses	
Built 2 water-tanks	8 by 8
Built 1 blacksmith shop	40 by 20

STRIPPING QUARRY.

Trees and stumps removed		
Earth removed	cub. yds.	1
Solid sandstone removed	do	5
Loose stone removed	do	3

Graded and laid 2,879 linear feet of tramway in track and switches.

Built 185 linear feet of trestling for tramway and 115 linear feet of timber b protection above quarry.

Dressed and built 5 derricks for handling stone in quarry and yard.

DIMENSION STONE QUARRIED.

	Cubic y
May, 1888	
June, 1888	

DRESSED STONE.

Date.	Character of stone.	Qua
		Cub
May, 1888	Face	
Do	Squared	
Do	Backing	
June, 1888	Face	
Do	Squared	
Do	Backing	

The quarry is now in excellent shape for getting out stone very rapidly.

UPPER KENTUCKY RIVER.

No work has been done on the shoals between the Kentucky Central Railroad C ing at Ford and Beattyville, since the season of 1875, and as many of the wing- constructed to throw more water over the shoals during the low-water season a *bad condition*, I would most earnestly recommend that some work be done a *worst shoals* this season.

The river is the only highway the people of Beattyville and Proctor and surrounding country have for obtaining supplies. Two steam-boats run when the stage of water will permit, and during the dry season push-boats run regularly.

Two thousand dollars expended on this portion of the river would be of great benefit.

Accompanying this report is a statement of the commercial statistics for Beattyville Dam and vicinity for the fiscal year ending June 30, 1888.

Respectfully submitted,

R. S. BURNETT,
Assistant Engineer.

Capt. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics for fiscal year ending June 30, 1888—*Beattyville Dam and vicinity, Kentucky River, Kentucky.*

Articles.	Quantities.	Average price.	Value.
Coal ..... bushels..	49,675	$0.14	$6,954.50
Flour ..... barrels..	1,698	6.00	10,188.00
Grain ..... bushels..	3,819	.70	2,673.30
Hay ..... tons..	340	14.00	4,760.00
Hogs ..... number..	450	6.00	2,700.00
Hides ..... do....	280	4.00	1,120.00
Iron, manufactured ..... tons..	25	75.00	1,875.00
Lumber:			
Oak ..... feet B. M..	186,500	18.00	3,357.00
Poplar ..... do....	283,665	16.00	4,538.64
Machinery	.....	.....	17,900.00
Salt ..... barrels..	1,344	2.00	2,688.00
Staves ..... M..	180,000	40.00	7,200.00
Stone ..... cubic yards..	10,800	1.00	10,800.00
Ties, railroad ..... number..	74,692	.40	29,876.80
Timber ..... linear feet..	36,250	.12	4,350.00
Oak logs ..... number..	58,857	3.00	176,571.00
Poplar logs ..... do....	46,850	3.00	140,550.00
Walnut logs ..... do....	18,105	10.00	181,050.00
Tobacco ..... hogsheads..	85	100.00	8,500.00
Whisky ..... barrels..	129	75.00	9,675.00
Wood ..... cords..	680	3.00	2,040.00
Miscellaneous merchandise, 48,638 tons, at $2 per ton			97,276.00
Passengers, 1,604, at $2.50 each			4,010.00
Total			730,653.24

E E 2.

OPERATING AND KEEPING IN REPAIR THE FIVE LOCKS AND DAMS ON THE KENTUCKY RIVER, KENTUCKY.

This work was in temporary charge of Maj. Amos Stickney, Corps of Engineers, until April 17, 1888, when it was transferred to my charge.

When these locks were transferred to the United States by the State of Kentucky it was found that a vast amount of work was required to put them in proper condition. Most of the dams have been entirely rebuilt, the others nearly so. New abutments have been constructed, as well as guide-walls above and below the locks, while extensive shore protection has in some cases been found necessary to prevent washing of banks.

At present there is good slackwater navigation to Oregon, 99 miles from the Ohio River.

The work of the past year has been carried on with a view to establishing the security of the locks, dams, and accessories, and that projected for the fiscal year ending June 30, 1889, has the same object in view. Barring unforeseen accident, when the work for the ensuing year

is completed it may safely be estimated that the cost of repairs for a number of years will be merely nominal, depending upon the life of timber exposed, as that in the dams, abutments, guide-walls, etc., is.

During the year there have been no losses from accidents due to imperfect facilities for passing the locks.

Experience has shown that it is cheaper to do the necessary dredging about the lock entrances by hired labor, using the Government dredge. The one now in use is an old one, that was once condemned, but which so far has been able to do the work by aid of extensive and expensive repairs.

It would be sound economy, in my opinion, to purchase or build a new dredge of sufficient capacity for the work, rather than trust to the one now in use, which is liable to become disabled at any time.

The work of repairs at the different locks during the past year was quite extensive, and was all completed before I assumed charge. The report of Assistant Engineer R. S. Burnett, who was in local charge during all the time the repairs were being made, is submitted herewith. It gives all the details of what was done, and attention is respectfully invited to it.

It is proposed to apply the allotment for the fiscal year ending June 30, 1889, as follows:

LOCK NO. 1.

Complete the paving of bank between lock-wall and turnpike.
Complete the filling of cribs in the abutment and extension.
Construct a fence around United States property.
Rebuild lower-shore guide-wall.
Rebuild lower-river guide-wall.
Dredge lock entrances.

LOCK NO. 2.

Construct new stone abutment.
Complete paving of bank at lock.
Build new lock-house.
Repair sheeting of dam.
Dredge lock entrances.

LOCK NO. 3.

Raise extension of abutment below the dam.
Repair coping of lock-walls.
Construct one single house for lock-keeper.
Grade and repair bank behind lock-wall.
Dredge lock entrances.

LOCK NO. 4.

Rebuild lower-shore guide-wall.
Grade and pave bank behind lock-wall.
Build one single house for assistant lock-keeper.
Dredge lock entrances.

LOCK NO. 5.

Level up dam where settlement has taken place.
Pave and grade bank behind lock-wall.
Build one single house for keeper.
Fence Government land.
Dredge lock entrances.

In addition to the above, it is proposed to replace the old balance-valves of the wickets in the upper lock-gates at Locks Nos. 1, 2, 3, and 4 by slide-valves.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1888.

CAPTAIN: I respectfully submit the following report on the operating and care of canals and the maintaining and preserving of navigation on the Kentucky River for the fiscal year ending June 30, 1888.

All the work projected at the several locks for their safety and that of navigation was completed during the year.

Most of the stone used in repair work was excavated from a quarry at Lock No. 2 by hired labor.

There has been no damage done at several locks from any cause during the past year; not a craft of any description has been lost.

The triangular guide-piers constructed to prevent crafts from going over the dams have added greatly to the safety of navigation.

Corporations controlling bridges have been compelled to place channel lights on their bridges.

The past year has been a remarkable one for small amount of rain, and consequently low water, there having been but one good raft freshet during the year, which leaves fully 75 per cent. of logs cut in the mountains on the ground.

Most of the whisky distilleries suspended operations last year, and this, taking into consideration the drought, will account for no increase of commerce on the river.

The following is a detailed statement of work done during the past year and that projected for the fiscal year ending June 30, 1889.

When this work has been completed the locks will require but small expenditures annually to keep them in repair for at least fifteen years, barring accidents.

Lock No. 1.

New breast to dam.—The old dam leaked so badly that the pool was lowered 3 fee August 31, and was yet falling.

The new breast was constructed by driving oak pile sheeting continuously across the river from the lock side, 16 feet above the old breast, to a point 422 feet from the lock-wall, where a return wing was made up the river 52 feet, and thence to the extension of the abutment a distance of 32 feet.

This was done for the purpose of including a number of very large leaks extending through the riprap stone filing under the abutment.

All the pile sheeting was driven with a 2,000-pound hammer a distance of from 16 to 40 feet, and where piling was driven more than one-quarter inch from the adjoining pile extra sheeting was put down, closing the joint.

The space of 16 feet between the old and new breast was thoroughly filled and packed with clay, stone, and gravel up to the bottom of the floor, connecting the new breast on to the slope of the dam,

The pile sheeting was sawed off at an elevation of 3 feet 5 inches below the crest of the dam, and a floor laid of one course of oak sheeting 6 inches in thickness, with a top course 3 inches thick, breaking joints, and connecting the new breast to the dam. The new breast was well backed with clay and gravel.

The following material was expended in the work, viz:

White oak pile-sheeting	feet, B. M..	101,068
White oak floor-sheeting	do....	151,884
Clay and gravel backing	cubic yards..	4,330
Steel spikes	pounds..	7,905
Cast-iron shoes for piles		550

DAM.

Defective step-sheeting was removed and replaced with 22 new oak pieces; 67 pieces of old step-sheeting were respiked.

The dam was raised 6 inches at the crest, which now gives, with the pool just full, 6 feet on the lower miter-sill at Lock No. 2.

Material expended in the above work.—White oak lumber, 7,950 feet, B. M.; steelt spikes, 425 pounds.

Extension of abutment below the dam.—The old extension work protecting the wash-out had become completely unserviceable. A crib wall filled with riprap stone was constructed from the abutment extending down the river to the shore end of the old dam, a distance of 331 feet. Width 14 feet at the bottom and 12 feet on top, with a height of 35 feet from the bed of the river, which made the top of the wall 4 feet 4 inches below the top of the abutment.

Thirty oak piles were driven, 6 feet apart, to a depth of 16 to 20 feet along the face of the wall, to protect it from pressure from behind.

The following material was expended in this work, viz:

Hewed oak timber	linear feet	35,510
Riprap stone	cubic yards	4,548
Oak sheeting	feet, B. M.	15,600
Spikes	pounds	14,175
Clay	cubic yards	20

Thirty piles 16 by 9 inches by 25 feet, were removed from foundation.

Extension of abutment above the dam.—The bank at the end of the old wall has commenced to cut through and around the abutment. This wall was lengthened 32 feet and the new work raised 3 feet 10 inches to the top of the bank. The old extension and abutment were raised an average of 18 inches.

The entire river face of the abutment and extension, 210 feet in length, was re-sheeted with oak sheeting.

Material expended as follows, viz:

Hewed white oak sheeting	linear feet	1,994
Riprap stone	cubic yards	496
3-inch oak lumber	feet, B. M.	6,140
Spikes	pounds	620
Clay as backing	cubic yards	290

The miter-sill was found to be bolted into the soap-stone with iron split and wedged bolts 48 by 1¼ inches, some of which could be pulled up by hand.

The sill was rebolted with steel bolts 84 by 1¼ inches, pointed and bearded on the end, and driven into white pine plugs, dropped to the bottom of the bolt-holes which were drilled 3 feet 6 inches into the rock; before putting on the taps the space around the bolts was filled with sand to the top of the sill.

The old grouting between the miter-sill and mud-sills, both at the upper and lower gates, had been entirely washed away. These spaces were refilled with oak sheeting cut to fit, caulked with oakum, and spiked independent of the sills.

No leakage can now take place under these sills, unless they raise over 1 foot, while before the grouting adhered to the sills and raised with them.

The gates were found to be wider than length of miter-sill and they would not miter against it. The sill was lengthened by adding a strip of oak to its upper face, on which the gates now miter.

All holes cut out by the action of the water in the soap-stone were filled with rubble masonry. Where floor had been washed out a new one was laid on 12 by 12 inch oak-floor timbers, laid 3½ feet apart at right angles with the lock-pit, and bolted into the soap-stone with 72 by 1¼ inch steel bolts. The spaces between these timbers were grouted, and an entire new oak floor was spiked to the timbers.

MATERIAL EXPENDED ON THIS WORK.

Repairing tail-bay and lock-pit.—An examination showed that the lower miter-sill had raised about 6 inches, also that all the old protection flooring below the lower gates in the tail-bay had been scoured out.

The soft soap-stone on which part of the lock-walls rest had been cut away in places to a depth of from 2 to 5 feet, endangering the walls.

A coffer-dam was constructed, starting at the lower end of the outside lock-wall and extending 85 feet along the outside of the river guide-wall; thence through this wall at right angles, across the tail-bay and through the shore guide-walls into the bank, making a total length of 148 feet of coffer-dam.

The upper gates were coffer-dammed by placing canvas over the filling valves and depositing sawdust in the head-bay in front of the gates.

The coffer-dam was pumped dry and the inclosure cleared of a large deposit of mud.

All castings on the lower gates were found broken, miter-sill raised, and flooring-timbers and grouting gone, for a distance of 70 feet down-stream from the miter-sill.

The breast-wall was also washed away, and the soap-stone cut out badly.

The lower gates were jacked up and an entire new set of pintles, pintle-seats, and bonnets put on.

New top rails and five other arms were placed; all iron rods used to operate valves were taken off and strengthened.

Oak, 2 by 3-inch sheeting in coffer-dam	feet, B. M.	44,541
Canvas	square yards	300
Sawdust	bushels	6,000
Oak sheeting, flooring tail-bay and lock-pit	feet, B. M.	42,500
Spikes	pounds	1,750
Drilling for bolting timbers and sills	feet	240
Grouting	cubic yards	30
Pumping by U. S. snag-boat *Kentucky*	hours	197
Assorted drift-bolts		80
Broken stone	cubic yards	45
Clay as backing for coffer-dam	do	540

Upper shore guide-wall.—The old wall was strengthened and raised 26 inches, and a new return extension to top of the bank constructed.

Dimensions of wall are: Length, 153 feet; width, 12 feet; and height from foundation, 22 feet at the angle to 4 feet at the bank end. The new extension was constructed in steps, aggregating at the top of the bank 11 feet 2 inches above the top of the lock-wall.

Material expended in this work as follows, viz:

Hewed white oak timber	linear feet	2,320
Riprap stone	cubic yards	276
Spikes	pounds	740

Upper river guide-wall.—To raise this work to a height of 2 feet 3 inches above the top of the lock-wall, 24 feet was raised 3 feet, and 36 feet raised 1½ feet, with new oak cribbing filled with riprap stone.

Material expended:

Oak timber	linear feet	570
Riprap stone	cubic yards	296
Spikes	pounds	57

Triangular guide-piers.—On account of the location of this dam, which has been constructed very nearly abreast of the lower gates, as well as the great depth of water at the head of the upper river guide-wall, it was determined to construct but one pier.

This was constructed 30 feet from the upper end of the river guide-wall.

The plan of this pier was an equilateral triangle with 30 feet on a side, the height of the pier 28 feet.

Material expended:

Oak timber	linear feet	2,106
Riprap stone	cubic yards	423
Spikes	pounds	205

Repairs to lock-wall.—Twenty-five cubic yards of defective coping and special stone were removed, and 20 cubic yards new coping and special stone set.

Material expended:

Coping and special stone	cubic yards	20
Cement	barrels	8
Sand	cubic yards	12

Paving slope between lock and turnpike.—Six hundred and twenty-seven square yards of old paving immediately behind the lock-wall were taken up, the bank was uniformly graded from the pike to the lock wall, and 992 square yards of new paving placed. This paving should extend to the turnpike, and the remainder is contained in the project for the fiscal year ending June 30, 1889.

Material expended:

Paving stone	cubic yards	456
Clay and gravel filling	do	2,210

Abutment of old dam.—Five hundred and sixty-five linear feet of old timbers were taken out to stop the reaction of the water causing scour around the face of the new extension to the abutment protecting the wash-out.

Dredging.—The lower entrance and tail-bay of lock were dredged by the United States dredge.

Material removed:

Clay, sand, and gravel	cubic yards	2,460

Navigation was suspended at this lock from September 17 to October 1, while repairs were being made.

There was no suspension from any other cause during the year.

The highest water occurred April 1, when the lower gauge read 37.50 feet.

During the months of October and November the lower gauge read 3.50 feet almo continuously.

Project for year ending June 30, 1889.—Complete paving bank between lock-wall a turnpike Complete filling cribbing in the abutment and extension. Constructi of fence around United States property. Rebuilding lower shore guide-wall. R building lower river guide-wall. Dredging lock entrances.

LOCK NO. 2.

Repairs were made to this lock as follows:

Upper shore guide-wall.—This wall was raised 27 inches to bring it to this heig above the lock-wall.

One hundred and nine cubic yards of stone and 165 linear feet of defective oak t bers were removed from the cribbing.

The bank behind the wall having settled, was filled and sloped.

Material used as follows:

Oak timber	linear feet..	
Gravel backing	cubic yards..	
Riprap stone placed in the cribbing	do....	
Stone used as backing	do....	7

Paving bank behind the lock-wall.—Removed 254 square yards of old paving.

Graded and filled in with 115 cubic yards of earth and gravel and set 565 squa yards of new paving stone.

Dam.—The old step-sheeting was respiked and ten defective pieces of sheeting r moved and replaced with new oak timber.

Lower river wall.—Removed 2,005 linear feet of old, defective timber and 700 cub yards of stone.

Placed in raising this wall to top of lock-wall:

New oak timber	linear feet..	6,0
Riprap stone	cubic yards..	1,0

Upper river guide-wall.

Removed defective oak timber	linear feet..	3,3
Removed riprap stone	cubic yards..	66
Removed sand and earth	do....	60

Placed in raising this wall 27 inches above top of lock-wall:

Oak timber	linear feet..	8,06
Riprap stone	cubic yards..	80

Lower shore guide-wall.

Removed for foundation of new wall:

Earth and gravel	cubic yards..	43
Solid rock	do....	50

Placed in constructing new wall to top of lock-wall:

Of oak timber	linear feet..	11,34
Riprap stone	cubic yards..	2,11

The wall was backed with 850 cubic yards of stone.

Triangular guide piers.—Constructed two triangular piers at the head of the uppe river guide-wall.

The plan of these piers was an equilateral triangle with 30 feet on a side; th heights were 25 feet respectively.

Material used:

Hewed oak timber	linear feet..	4,08
Riprap stone filling	cubic yards..	85

Abutment.—Cut and reset three defective face stones and replaced the face masonry

From the cribbing extension-wall below the dam, there was removed:

Defective oak timber	linear feet..	77
Stone	cubic yards..	7

Quarry.—A quarry was opened at this lock for the purpose of obtaining riprap ston for the repair work at the several locks, as well as to obtain a site for a new lock keeper's dwelling above the high-water line; the old dwelling is now flooded at hig water.

Removed in stripping quarry 1,526 cubic yards of sand and gravel, quarried 8,221 cubic yards of riprap stone, quarried and dressed 98 cubic yards of coping and special stone for Locks Nos. 1 and 4.

Dredging.—The United States dredge removed 1,520 cubic yards of material from the lower entrance to lock and 1,120 cubic yards from the upper entrance.

Navigation was suspended at this lock two weeks on account of repairs at Lock No. 1. Pool No. 1 did not fill up, however, for a period of two weeks longer, there being no rain.

There was a suspension of navigation for the last two days of December on account of ice.

Lowest gauge reading on lower miter-sill was, on August 31.2.9 feet.

Highest reading, March 31, 30 feet.

Project for the fiscal year ending June 30, 1889.—New stone abutment completing paving of the bank behind lock-walls; constructing new lock-house; repairing sheeting of dam; dredging lock entrances.

LOCK NO. 3.

Lower shore guide-wall.—A new lower shore guide-wall was constructed entire. Removed 1,506 cubic yards of solid stone for foundation, also 360 cubic yards of sand and gravel.

Expended of oak timber in cribbing	linear feet..	10,480
Placed riprap stone in wall	cubic yards..	1,574
Placed stone as backing to the same	do....	535

Dimensions: Length, 256½ feet; height, 25½ feet; width, 12 feet.

Lower river guide-wall.—This was raised to top of lock-wall, with the following expenditure of material:

Oak timber	linear feet..	2,033
Riprap stone	cubic yards..	294

Dimensions of new work: Length, 75 feet; height, 7 feet; width, 10 feet.

Upper shore guide-wall.—In raising this wall to a height of 2 feet 3 inches above the top of the lock-wall 215 cubic yards of earth and stone and 480 linear feet of defective oak timber were removed; 1,865 linear feet of oak timber and 344 cubic yards of riprap stone were expended in cribbing.

Dimensions of new work: Length, 180 feet; height, 4½ feet; width, 8 feet.

Upper river guide-wall.—The cribbing in this wall required filling with 120 cubic yards of riprap stone.

Triangular guide-piers.—Two triangular guide-piers were constructed at the head of the upper wall.

The plan of these piers was an equilateral triangle with 30 feet on a side; their heights were 31 and 26 feet respectively.

Material expended as follows:

Oak timber	linear feet..	5,480
Oak sheeting and grillage	feet, B. M..	4,654
Riprap stone	cubic yards..	776

Jetty cribs below the abutment.—Two spur jetties had formerly been constructed for the purpose of breaking up the strong reaction of the water which had been cutting the bank and endangering the abutment. From their peculiar construction and location they accelerated the cutting.

They were cut down at the lower ends and the material used in continuing them to the top of the bank by stepping them back.

Repairs to lock-house.—All doors and frames repaired. Two new flights of steps built. All window frames repaired. Two sills replaced. Roof partly reshingled.

Extension of abutment below the dam.—In raising this cribbing work 2,694 lineal feet of oak timber and 702 cubic yards of riprap stone were expended.

Dimensions of new work: Length, 225 feet; height, 7½ feet; width, 11 feet.

Extension of abutment above the dam.—In raising this work to guard against the river cutting around the abutment 396 linear feet of oak timber and 100 cubic yards of stone were expended.

Dimensions of new work: Length, 91 feet; height, 4 feet; width, 12 feet.

Dam.—Old defective step-sheeting was removed and 32 new pieces placed. All old sheeting was respiked.

Dredging.—From the lower entrance 310 cubic yards of solid rock were removed and 841 cubic yards of deposit. There was no suspension of navigation at this lock. Lowest reading of the gauge on lower miter-sill 5 feet, August 22; highest, March 31, 21 feet.

Project of work for the fiscal year ending June 30, 1889.—Raising extension of the abutment below the dam. Repairing coping of lock-walls. Constructing one single house for lock-keeper. Grading and repairing bank behind lock-wall. Dredging lock entrances.

[illegible] .....
Clay .....
Brush .....

Upper river guide-wall.—This was raised 18 inches to
inches above the top of the lock-wall. Dimensions: L
The following materials were expended:

Oak timber .....
Riprap stone .....
Spikes .....

Lower river guide-wall.—In raising this wall to top of
120 by 12 by 10 feet) the following material was expende

Oak timber .....
Riprap stone .....
Spikes .....

Dam.—Ten defective pieces of step-sheeting were ren
old step-sheeting was respiked.

Triangular guide-piers.—Two piers were constructed at
guide-wall. The plan of these piers was an equilateral tr
and their heights 28 and 36 feet, respectively.

The following material was expended:

Oak timber .....
Riprap stone .....
Spikes .....

Lock-house.—Bids were solicited, to be opened June
keeper's dwelling at Lock No. 4.

Mr. Mike Buckley, of Frankfort, Ky., the lowest bidde
The building was completed and accepted.

Operating and general care of lock.—Two old buildings
were taken down and removed. Took down old fence a
built same out of new material. Put in concrete floo
Graded ground around new lock-house. Painted and re
rods. Reweather-boarded two sides of the old lock-ho
windows, and frames. Partly reshingled roof.

Navigation was suspended at this lock one day, on
drift in the head bay.

Lowest reading on lower miter-sill, November 8, 4.8 fe
feet.

Dredging.—Removed 684 cubic [illegible]

GENERAL WORK.

Lock-house.—Repaired doors, windows, and window-frames; built two flights of steps; laid two new hearths; set three new fire-grates; two back chimneys were partly taken down and rebuilt; cleaned out and repaired wall; painted lock-gates; repaired road to Lawrenceburg with material taken from Government land.

Navigation was suspended one day, December 31, on account of ice.

Lowest gauge reading on lower miter-sill, September 17, 4.2 feet; highest, March 31, 24.1 feet.

Project for the fiscal year ending June 30, 1889.—Leveling dams where settlement had taken place; paving and grading bank behind the lock-wall; constructing one single dwelling for keeper; fencing Government land; dredging lock entrances.

United States snag-boat Kentucky.—The boat has been engaged in taking out snags, acting as tender to the United States dredge, towing stone-barges and hoisting stone into the new cribbing at the several locks, hoisting cribbing timber on walls repaired and built at Locks Nos. 1, 2, and 3; constructing coffer-dam for repairing tail-bay at Lock No. 1; pumping out same, one hundred and ninety-seven hours; hauling out stone-barges and repairing same; assisting in making repairs on United States dredge; towing the United States dredge and scows to the several locks where dredging was required; making trip to Cincinnati for stone-barges; making trip to Cincinnati for repairs; towing derrick-boat from Carrollton to Lock No. 6.

Made trip to Beattyville April 10, taking up plant for operating quarry.

Removed 73 snags from the river channel.

Total miles run, 2,286.

Repairs were made as follows: Put in two new cylinders, three pairs of front lines to furnace, two new mud-drums, new sheet-iron apron on boiler in front of flue-caps. Cut holes and riveted flanges in steam-drum. Put in two new branch pipes from throttle to cylinder, also new doctor-beam; tightened wrist on shaft and shrunk band on same. Put in new beds to capstans and spindle and overhauled both capstans; placed new bell in engine-room. Reduced circle and enlarged buckets to wheel. Put on deck ten new iron cavils; rebraced and rebolted cylinder timbers. Partially repainted boat. Built new fire-wall and new furnace and repaired smoke-stacks.

UNITED STATES DREDGE.

The dredge transferred from the Louisville and Portland Canal was partially repaired at Cincinnati, and after working a short time, it was found necessary to make further repairs to both it and the dump-scows.

This work was done by the crew of the snag-boat, as follows:

Old cabin taken off and new one built; put in new bulkheads all around the boat; put in new sides to crane; put in new hoisting drum, new swinging wheels, new sleeves, new hoisting pinion, new hoisting clutch, new break wheel, new guide-plates for levers and new fulcrums. Built new dipper handle and painted boat throughout.

The dredge has been employed in dredging clay for backing coffer-dam and dam at Lock No. 1 and hoisting timber, and dredging lock entrances.

Dredging on the river with this dredge, operated in connection with the snag-boat, has reduced the cost to about 8 cents per cubic yard.

Lock No. 1.—Dredged 41,330 cubic yards of clay and gravel for backing Dam No. 1 dredged 2,460 cubic yards of clay, sand, and drift from the lower entrance at Lock No. 1;

Lock No. 2.—Removed 1,520 cubic yards from the lower entrance, and 1,120 cubic yards from the upper entrance.

Lock No. 3.—Removed 1,737 cubic yards of deposit from lower entrance.

Lock No. 4.—Removed 684 cubic yards of deposit from entrances and lock pit.

UNITED STATES DERRICK BOAT.

A pile-driver was placed on the boat and 426 sheet piles were driven to an average depth of 26 feet, for the new breast to Dam No. 1.

Hoisting crib-timber, and stone at all the locks while repairs were being made.

Old hoisting engine, worn out, was removed and new double drum Mundy hoisting engine put in in its place.

Repaired deck and calked sides.

STONE BARGES.

The two barges were hauled out on the bank of the Ohio River.

New rakes and new bulkheads were put in and calked.

The sides of both barges were calked and timber-heads were repaired. The following papers accompany this report, viz:

Statement of lockages.

Commercial statistics for fiscal year ending June 30, 1888.

Respectfully submitted,

R. S. BURNETT,
Assistant Engineer.

Capt. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATIC
NANCE OF NAVIGATION OF KENTUCKY RIVER, KENTUCKY.

Detailed statement of expenses incurred in preserving and maintaining navig portion of the Kentucky River improved by locks and dams during the fiscal ye

LOCK No. 1.

Months.	Outstanding liabilities.	Salaries.	Labor and material.	Dredging.	Curr and ting expe
1887.					
July	$1,014.69	$197.30	$539.85	$331.83	$17
August	.....	213.77	3,646.84	114.81	28
September	.....	229.60	3,014.20	57.40	1
October	.....	166.20	11,179.48	125.41	7
November	.....	227.40	7,817.55	269.60	2
December	.....	269.00	1,624.52	21.76	1
1888.					
January	.....	95.00	54.33	14.12	21
February	.....	235.20	5.81	.....	21
March	.....	95.00	.....	.....	.....
April	.....	159.00	.....	.....	1
May	.....	161.50	.....	.....	3
June	.....	95.00	18.19	154.34	.....
Total	1,014.69	2,143,97	27,900.77	1,089.27	20

LOCK NO. 2.

1887.					
July	$1,051.61	$176.00	$203.77	$331.83	$15
August	.....	235.75	1,980.18	114.81	40
September	.....	69.00	3,291.62	57.40	18
October	.....	163.59	6,784.81	125.41	12
November	.....	278.90	2,087.39	269.60	30
December	.....	201,70	526.98	21.76	2
1888.					
January	.....	95.00	.....	14.12	.....
February	.....	244.20	5.81	.....	15
March	.....	95.00	.....	.....	.....
April	.....	159.00	8.39	.....	.....
May	.....	159.00	.....	.....	.....
une	.....	95.00	14.45	154.33	.....
Total	1,051.61	1,972.14	14,903.31	1,089.26	135

LOCK NO. 3.

1887.					
July	$1,083.32	$310.38	$300.40	$331.83	$15
August	.....	255.86	613.78	114.82	12
September	.....	242.55	412.80	57.40	10
October	.....	276.20	4,502.68	125.41	12
November	.....	278.90	1,476.06	269.60	30
December	.....	169.00	353.65	21.76	8
1888.					
January	.....	95.00	4.00	14.12	.....
February	.....	238.20	29.80	.....	7
March	.....	95.00	.....	.....	.....
April	.....	160.00	.....	.....	.....
May	.....	159.00	.....	.....	.....
June	.....	95.00	8.00	154.33	.....
Total	.....	.....	.....	.....	.....

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River improved by locks and dams, etc.—Continued.

LOCK NO. 4.

Months.	Outstanding liabilities.	Salaries.	Labor and material.	Dredging.	Current and contingent expenses.	Total.
1887.						
July	$1,634.70	$176.00	$0.40	$331.83	$15.22	$2,158.15
August		287.90	.00	114.82	19.98	422.70
September		182.55	.00	57.40	10.56	250.51
October		176.20	4,699.33	125.41	12.32	5,013.26
November		178.90	1,189.26	269.60	26.42	1,664.18
December		69.00	903.91	21.76	2.70	997.37
1888.						
January		113.00	125.53	14.12	11.07	263.72
February		248.17	18.59	.00	21.09	287.85
March		107.75	.00	.00	.00	107.75
April		159.00	.00	.00	1.50	160.50
May		159.00	.00	.00	.00	159.00
June		95.00	.00	154.33	.00	249.33
Total	1,634.70	1,952.47	6,937.02	1,089.27	120.86	11,734.32

LOCK NO. 5.

1887.						
July	1,063.08	213.20	5.60	331.84	15.22	1,628.94
August		241.40	5.58	114.82	12.48	374.28
September		202.55	.00	57.40	10.56	270.51
October		171.20	1,545.60	125.42	12.32	1,854.54
November		173.90	588.61	269.60	26.42	1,058.53
December		200.00	.00	21.76	2.70	224.46
1888.						
January		95.00	.00	14.12	11.07	120.19
February		235.20	17.63	.00	8.70	261.53
March		107.00	12.00	.00	.00	119.00
April		159.00	.00	.00	6.45	165.45
May		159.00	.00	.00	.00	159.00
June		95.00	10.05	154.33	.00	259.38
Total	1,063.08	2,052.45	2,185.07	1,089.29	105.92	6,495.81

RECAPITULATION.

Lock No. 1	$32,354.78
Lock No. 2	19,151.32
Lock No. 3	12,346.08
Lock No. 4	11,734.32
Lock No. 5	6,495.81
Snag-boat	7,344.90
Total	89,427.21

COMMERCIAL STATISTICS.

Trade of Lower Kentucky River, Kentucky, for fiscal year ending June 30, 18

Articles.	Quantities.	Average price.	
Beer ..... cases..	1,435	$2.00	
Brick ..... number..	32,875	7.00	
Coal ..... bushels..	941,743	.15	1
Cooperage:			
Barrels ..... number..	13,144	1.50	
Hogsheads ..... do....	4,215	2.50	
Staves	132,000,000	25.00	
Flour ..... barrels..	18,222	5.00	
Grain ..... bushels..	196,358	.70	1
Hay ..... tons..	3,010	14.00	
Hemp ..... do....	11	125.00	
Hides ..... number..	837	400.00	
Iron, manufactured ..... tons..	600	70.00	
Junk ..... do....	325	20.00	
Lime ..... barrels..	2,316	1.00	
Live-stock:			
Cattle ..... number..	1,148	40.00	
Hogs ..... do....	6,171	8.00	
Horses ..... do....	361	100.00	
Sheep ..... head..	500	3.50	
Lumber, assorted ..... feet, B. M..	1,717,850	18.00	
Lumber, walnut ..... do....	80,000	60.00	
Produce	.....	.....	
Salt ..... barrels..	12,390	2.00	
Stone ..... cubic yards..	25,739	1.25	
Ties, railroad ..... number..	49,797	.40	
Timber ..... linear feet..	274,190	.18	
Timber:			
Assorted logs ..... number..	114,690	5.00	
Walnut logs ..... do....	13,053	15.00	
Tobacco ..... hogsheads..	6,000	100.00	
Whisky ..... barrels..	34,368	100.00	3,
Wood ..... cords..	1,785	3.50	
Miscellaneous merchandise ..... tons..	20,385	250.00	5,
Passengers ..... number..	20,696	1.50	
Total	.....	.....	10,

Report of lockages for the fiscal year ending June 30, 1888.

Locks.	Number of days operated.	Number of days suspended.	Going up.			Going down.				Total craft and flats
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.	Miscellaneous.	
No. 1	351	14	327	134	107	319	131	51	83	1,
No. 2	349	16	280	122	222	280	105	133	253	1,
No. 3	365	.....	231	120	88	227	115	44	75	
No. 4	364	1	256	132	84	249	154	91	71	1,
No. 5	364	1	161	142	81	161	148	1,324	87	2,
Total	1,793	32	1,255	650	582	1,236	653	1,643	569	6,

Total increase of lockages over the fiscal year ending June 30, 1887, 207.

E E 3.

IMPROVEMENT OF THE BIG SANDY RIVER, WEST VIRGINI KENTUCKY.

This river was under temporary charge of Lieut. Col. W. E. N Corps of Engineers, until April 13, 1888, since which time it ha under my charge.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks at Louisa, flows north a distance of 26 miles, and empties into the Ohio at Catlettsburgh, Ky. The main river and the Tug (or eastern) Fork form the boundary line between West Virginia and Kentucky, and the upper part of the Tug, for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia, and flows north-northwest to its junction with the Levisa Fork, with a total length of about 140 miles. The Levisa (or Louisa) Fork rises in the southwestern part of Virginia, whence it enters Kentucky, and flows in a northerly direction. Its total length is about 189 miles. The total length of the Big Sandy River is therefore 215 miles.

The present approved project for the improvement of this river contemplates the construction of a lock and dam at Louisa, below the junction of the two forks, and also the improvement of open river navigation on these forks and on the main river. The object of building the dam is to form a pool for holding coal-boats and barges, with a view to the shipment of coal from the extensive deposits found in the valley. It is expected that other locks and dams will be built if this preliminary one should prove a success. For open river navigation on the forks it is intended to secure a channel with a minimum depth of 1 foot and a minimum width of 50 feet during six months in the year. At present the forks are chiefly used for rafting, but there is occasional navigation as far as Piketon and Warfield by light-draught steam-boats, and a large amount of material is poled up the river in push boats. The country is mountainous, the roads are few in number and in poor condition, and the river is the chief reliance for obtaining such articles as can not be grown or manufactured in the country.

During the year the abutment for the dam at Louisa has been completed and the up-stream entrance to the lock blasted out. The work of clearing the lower approach was also commenced, but a large amount of rock must still be cleared out to render this approach available, estimated at 20,000 cubic yards.

Below the lock a number of snags, fallen and leaning trees, were removed, and rocks in and near the channel blasted out. The obstructions to low-water navigation that hitherto had existed at Blaine's Point Belcher's Bar, and White's Creek in West Virginia, and White's Creek in Kentucky, were cleared away. There yet remain a number of points at which obstructions exist, and it is estimated that about $1,500 will be required to complete the work of placing this part of the river, 26 miles in extent, in proper condition.

On Levisa Fork snags, stumps, etc., were removed where they interfered with navigation and rocks blasted out. At Big White House shoal a wall 1,050 feet long, with a base of 7 feet and varying height, was built to protect the bank, and two gravel-bars on the west side of the chute were removed. At various other shoals needed improvements were made and there still remain other points at which slight improvements will be of material benefit to push-boat navigation. It is estimated that an additional sum of $3,000 will be required in removing other obstructions that still exist.

On Tug Fork the work extended above Louisa about 100 miles to Roughs, and consisted in the removal of snags, trees, and rocks, besides improving island chutes and removing or modifying mill-dams. It is estimated that about $2,500 can be profitably expended during the coming year in continuing this work.

As there is certain to be trouble each year from snags, fallen and lean-

ing trees, etc., this part of the river improvement can not be regard susceptible of completion, and a small annual appropriation will t fore be required. The river takes the place of roads, of which the very few and these of a poor character, so that the low-water navig by means of push-boats is a matter of great importance to the p on the Forks.

For details concerning the work done attention is invited to tl port of Mr. B. F. Thomas, the resident engineer, annexed hereto.

Money statement.

July 1, 1887, amount available	$10,
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,
July 1, 1888, balance available	3,
Amount appropriated by act of August 11, 1888	31,
Amount available for fiscal year ending June 30, 1889	34,
Amount (estimated) required for completion of existing project	31,
Amount that can be profitably expended in fiscal year ending June 30, 1890	31,
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Trade of Big Sandy River, West Virginia and Kentucky, for fiscal year 1887–'8

Articles.		Quantities.	Average price.	Va
Beans	pounds	78,454	$0.03	$
Beeswax	do	5,224	.25	1
Cattle	head	472	28.00	1
Coal, cannel	tons	4,225	3.00	1
Eggs	cases	5,908	4.50	2
Feathers	pounds	58,002	.44	2
Furs	bags	217	8.30	1
Ginseng	pounds	7,590	1.75	1
Hides	bales	1,498	2.20	1
Hogs	number	1,606	8.00	1
Horses	do	45	80.00	1
Leather	pounds	62,520	.28	1
Lumber:				
Poplar	feet, B. M.	375,000	25.00	1
Walnut	do	26,000	40.00	1
Poultry	dozen	3,835	3.00	1
Roots, assorted	pounds	35,400	.30	1
Sheep	number	783	2.50	1
Sorghum	pounds	2,679	16.00	4
Spokes		261,000,000	12.00	1
Staves		375,000,000	25.00	1
Tan-bark	cords	1,751	14.00	2
Ties, railroad	number	350,000	.40	14
Timber, logs:				
Ash	cubic feet	26,250	.12	1
Mixed	do	200,000	.10	2
Oak	do	385,000	.12½	4
Poplar	do	1,075,000	.15	16
Walnut	number	4,185	15.50	6
Walnut knots	pounds	21,150	.40	1
Wheat	bags	6,622	2.00	1
Wool	pounds	30,103	.25	1
Miscellaneous				1
Total exports				71
Add imports, miscellaneous merchandise	tons	14,215	100.00	1,42
Passengers per boats				1
Grand total				2,15

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1888.

CAPTAIN: The report for the year ending June 30, 1888, is herewith submitted.

The work under my charge is the construction of a lock and dam near Louisa, Ky., the Big Sandy River, and the removal of obstructions to navigation in the same ream and its two forks, the Levisa and Tug.

Up to the present nothing has been done upon the dam, and its character has not en fully decided upon. Experiments have been made to determine whether a sta- nary dam will fill with sand and permanently injure navigation. These, while not tirely satisfactory, prove the necessity of some provision for allowing at least a rt of the dam to remain open during freshets and permit the sand to go through.

The lock is completed, except the gates and wickets, and rests upon the solid rock, hich was blasted to the proper level. This rock is somewhat fissured and it may be cessary to concrete the chamber floor of lock after it is in operation. The lock is cated well in the bank, in order not to restrict the water-way of the river, and this cessitates the excavation of approaches at each end. During the year just closed e upper approach excavation was finished and the lower one put well under way. The material thus taken out, being solid rock, was used for filling the space behind e land wall of lock and protecting the bank below.

The abutment, which was over half done at the time of my last report, has been mpleted. It is built on piles and stands 350 feet from the outside lock-wall. A rge crib has been put in adjoining its lower end and it is proposed still further to otect it by other cribs reaching down to the solid rock. The embankment behind e abutment is only about one-third in.

REMOVAL OF OBSTRUCTIONS TO NAVIGATION.

Push-boats, carrying crews of men and supplied with all necessary tools and dyna- ite, were sent out during the last low-water season to remove snags, fallen and lean- g trees, stumps, rocks, etc., from the channel and shores, where they were likely interfere with navigation.

BIG SANDY RIVER, BELOW LOUISA.

A party, consisting of an overseer and thirteen men, left here on the 25th of July, 87, and returned August 20. They removed the following obstructions:

ees, averaging 82 feet long	107
ags, averaging 24 feet long	149
umps	200
lid rock, cubic yards	45
ose rock, cubic yards	12

The four trees at Blaine Point, which have been in the way for some time, were ken out, as also were the snags just below Blaine, one of which, a very large one, as in the middle of the channel and quite dangerous.

At Belcher Bar the channel was about closed up with trees and snags and these ere blasted out. A good many rafts "tore up" on this place last spring, but it is w perfectly safe.

At what is known as West Virginia White's Creek was a very bad piece of river, ing filled with stumps, snags, and trees, blocking navigation at some stages of ater.

The steamer *Spurlock* sank a barge here last spring, and other craft had serious ifficulty in getting through.

Everything in the nature of an obstruction has now been removed and this part of e river is in fine condition.

At Kentucky White's Creek a similar lot of obstructions had been a terror to rafts- en for some time, and these were also taken out.

These are the principal points operated upon, although snags, trees, stumps, and cks were taken out wherever in the way.

Work is still needed upon this river at various points, notably Rove Creek, Rush reek, Gragston, and Savage Branch, where large rocks should be removed.

It is estimated that about $1,500 would put this part of the river, 26 miles, in a erfectly safe and good condition. Of course subsequent improvements would have be made, as the backwater from the Ohio causes numberless snags to "sand up" nd lodge in all that part of the Big Sandy near it.

LEVISA FORK.

Work was begun upon Levisa Fork August 22, 1887, by a force of eighteen men.

Dangerous snags and trees were removed between Louisa and the railroad bridge; lso at Dock Miller's, Lis Garred's, Fish Trap, Dave Kise's, George's Creek, and be-

tween there and Richardson; between Graves's and Bumble Bee Shoals, John Border's Ripple; between Lost Creek and Chestnut Shoals, and below Jo Davis Bend, Vanhoose's, Jim Jeffs; below Paint Creek; Preston's Ripple, Hell's Gate, Ivy Shoal, Snag Bar, Stone Coal, and Long Shoal.

At Mud Creek a tree 125 feet long and 33 feet in circumference was removed from the channel, and at Muddy Branch a snag 60 feet long and 16½ feet in circumference was taken out.

A tree 135 feet long and 19½ feet in circumference was removed between Lost and Chestnut creeks. Dangerous rocks were blasted out at Graves's Shoal, Bumble Bee, Border's Ripple, Lost Creek, Chestnut, Jo Davis, Little and Big White House, Vanhoose, Wild Goose, Ward Ripple, Greasy, Buffalo, Jeffie's Ripple, Hell Gate, Preston Ripple, Moody George's, Sugar Loaf, Ivy, Grimes's, Stone Coal, and Long Shoal.

On the bend side of the river, at Lost Creek, a large rock, which has long been the cause of annoyance to craft of all kinds, was removed. It contained over 100 cubic yards, and was just in the edge of the chute.

Chestnut Shoal was lowered slightly at head and the chute was widened.

At Big White House Shoal a great deal of work was done, some of it caused by the railroad contractors having blasted large rock into it from their cut upon the bank.

A wall 1,050 feet long was built here, with base of 7 feet, and of varying height, generally low, to protect the bank and keep it from slipping in and obstructing the chute.

Two gravel-bars were also removed on west side of the chute.

At Vanhoose's Ripple the old wall was built a little higher, and a dam was put in at head and on east side, to confine the water to the chute.

The old wall at Greasy was repaired.

Buffalo Shoal, 33½ miles above Louisa, was in a very bad condition, and 17 men worked here 8½ days, removing rock, widening the chute, and otherwise improving navigation.

Three days were spent at Jeffie's Ripple at similar work.

At Hell's Gate a wall to confine the water was constructed and a gravel-bar removed in order to straighten the chute. The head of the shoal was somewhat lowered.

The walls at Wireman's Shoal were repaired and heightened, as were also those at Abbot.

At Sugar Loaf the river was obstructed with rock for a mile, and these were all removed.

A good and much needed improvement was made at Hawes's Ford, 61½ miles above Louisa, by clearing the shoal and blasting out the solid rock at its head, thereby lowering the chute.

The obstruction at Ivy, consisting of stone and snags, was taken out and the walls at Grimes's were repaired, and a new one put in on the west side, and the bar formed at the mouth of Still House Branch, just at the head of the shoal, was removed and the creek led into the river lower down.

The bad rocks at Stone Coal were removed, and the old walls at Long Shoal, 83.8 miles above Louisa, were repaired.

All the shoals between Louisa and Piketon, a distance of 86 miles, were thoroughly cleared of bowlders and large rocks that would interfere with navigation, and all the snags which would be dangerous to craft were taken out. More work, however, is needed at Contrary Creek, Peach Orchard, Lost Creek, White House, Wild Goose, Preston Ripple, Wireman's Shoal, Sugar Loaf, Ivy, and Laynesville.

It is believed that $2,500 to $3,000 could be profitably expended next season below Piketon, and a like amount above that point.

The river below Piketon is in much better condition than ever before, and the period of navigation has been greatly increased and its safety assured.

The season's work consisted of the removal of 211 trees, averaging 75 feet in length, 356 snags, 322 stumps, 1,744 cubic yards solid rock, and 3,200 cubic yards loose rock.

TUG FORK.

The boats left Louisa on June 4 last, and were out about two and one-half months, working an average of 12 men.

The following summary of work done is given, viz:

Trees removed (average length, 55.3 feet; average circumference, 9.2 feet)	81[illegible]
Snags removed (average length, 38 feet; average circumference, 8 feet)	6[illegible]
Cubic yards solid rock	1,41[illegible]
Cubic yards loose rock	1,12[illegible]

The part of the river worked over covers a distance of 100 miles, reaching to head [illegible] "Roughs."

The principal obstructions in the upper portions were islands and mill-dams. Notice had been given by Major Post that unless the mill-dams were so modified as not to interfere with navigation they would be removed by the Government, and this order was carried out.

The Bailey Dam, at head of Roughs, was taken out on west side of island where the natural channel is. The dam at Ben Creek was partly removed and a new boat chute cut through the J. C. Williamson Dam, it not being an obstruction to rafts.

Similar work has been done at the Thacker Dam, and some large trees taken out, and also at the Stafford Dam.

Part of an old dam at Lick Branch, 60 miles above Louisa, was removed and a new chute made.

Dangerous rocks were removed at Bailey's, Greenbrier, Turkey, Lick, and Trent's in the Roughs. One of these rocks contained 184 cubic yards.

From there down bad rocks were taken out at Williamson's Alum, Sleek Rock, Prater, Eph Hatfield's, Mate Creek, Jackson Bar, Spring Tail, Long Branch, Wolf, Crum Dam, and the Falls.

At the latter point, 10½ miles above Louisa, there has always been a bad obstruction known as the "Race Rock," being a high ledge directly in the way of craft at good stages of water. Eight days' work were done upon it with a dozen men, and it was lowered considerably, but it will be necessary to do as much more when we have money. It was 190 by 30 by 11 feet, the latter being its height.

Improvements were made at islands by widening and deepening the chutes, clearing off underbrush, removing rock bars, and confining the water to a single channel, which was straightened where necessary, notably at Bailey's, Greenbrier, Steel's, Grapevine, Spring Tail, and Alley. The latter place, having been worked upon the previous season, was found to be in excellent shape for navigation.

The shoals were well cleaned when necessary and all snags, trees, and stumps, which were an obstruction were removed, and the river is now in very fair condition, though there is yet much work to be done, and an appropriation of $2,500 is needed next season.

That part of the river used for steam-boat navigation needs but little work, but the upper part will have to be still further improved before rafts can be run in safety, and before push-boat navigation can be carried on successfully; and as these interests form a large part of the business of the upper country, and are increasing each year, it is highly important that the improvements be made at as early a date as possible.

The entire river for 100 miles is now in much better condition than ever before, and its business has largely increased since navigation has become safer and the period extended by reason of the work done by the United States.

A trip over the lower 77 miles of the river in a push-boat made last month by the writer proved the former work to have been well and intelligently executed, and that it had withstood both floods and ice remarkably well.

In conclusion, I desire to say that I have been ably and faithfully assisted in all my work by the overseers in charge of parties and boats.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Capt. D. W. LOCKWOOD,
Cincinnti, Ohio.

E E 4.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

This river was under the temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until April 13, 1888, since which time it has been under my charge.

The Guyandotte River rises in the southwestern part of West Virginia, flows in a northwesterly direction, and enters the Ohio 12 miles above the mouth of the Big Sandy and 39 miles below the mouth of the Great Kanawha.

At the date of the last annual report for this river, the appropriations for its improvement had been exhausted, so that during the past fiscal year no work of any kind has been done.

As there still exist other obstructions similar to those that have

already been removed, an estimate of $2,000 for future work is respectfully submitted.

Money statement.

Amount appropriated by act of August 11, 1888	$2,000.00
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics of Guyandotte River, West Virginia, for fiscal year 1887-'88.

Articles.	Quantity.	Average price.	Value.
Apples, dried ..... pounds	8,000	$0.04 per pound	$320
Apples, green ..... barrels	2,000	2.00 per barrel	4,000
Beans ..... bushels	500	2.00 per bushel	1,000
Beeswax ..... pounds	2,000	.25 per pound	500
Butter ..... do	6,000	.20 per pound	1,200
Corn ..... bushels	50,000	.50 per bushel	25,000
Eggs ..... dozens	40,000	.12½ per dozen	5,000
Feathers ..... pounds	13,000	.40 per pound	5,200
Furs ..... bags	50	8.00 per bag	400
Ginseng ..... pounds	15,000	1.75 per pound	26,250
Hides ..... do	6,000	.07 per pound	420
Honey ..... do	1,000	.20 per pound	200
Leather ..... do	1,000	.25 per pound	250
Oats ..... bushels	6,000	.40 per bushel	2,400
Peaches, dried ..... pounds	40,000	.05 per pound	2,000
Potatoes ..... bushels	2,500	1.00 per bushel	2,500
Roots, assorted ..... pounds	20,000	.30 per pound	6,000
Rye ..... bushels	2,500	.40 per bushel	1,000
Sheep pelts ..... bales	20	3.00 per bale	60
Sorghum ..... barrels	1,000	16.00 per barrel	16,000
Tallow ..... pounds	300	.04 per pound	12
Tobacco ..... hogsheads	150	100.00 per hogshead	15,000
Wheat ..... bushels	20,000	.75 per bushel	15,000
Wool ..... pounds	25,000	.25 per pound	6,250
Poplar logs ..... cubic feet	3,000,000	.13 per cubic foot	390,000
Oak logs ..... feet B. M	6,000,000	10.00 per M feet	60,000
Walnut logs ..... cubic feet	100,000	.60 per cubic foot	60,000
Sawed lumber ..... feet B. M	15,000,000	16.00 per M feet	240,000
Staves ..... number	3,000,000	25.00 per M	75,000
Hoop-poles ..... do	600,000	12.00 per M	7,200
Tan-bark ..... cords	1,000	15.00 per cord	15,000
Total exports			983,162
Total imports			400,000
Grand total			1,383,162

E E 5.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

This river was under the temporary charge of Lieut. Col. W[illegible] Merrill, Corps of Engineers, until April 13, 1888, since which dat[illegible] has been under my charge.

The Little Kanawha drains the central portion of West Virginia, [illegible]ing in Upshur County, and flowing thence in a course a little north[illegible] west until it empties into the Ohio at Parkersburgh; its total lengt[illegible] about 150 miles.

The present project for the improvement of the river, adopted in 18[illegible] and modified in 1880, contemplates the construction of a lock and d[illegible] to extend slackwater navigation for a draught of 4 feet a distance of [illegible] miles, and the improvement of the natural channel of the upper ri[illegible]

emoval of obstructions for a distance of 80 miles, the object of r being to obtain a channel of a minimum width of 40 feet, ng at least 2 feet of water during four months of the year.

close of the fiscal year work on the construction of the lock i suspended, and quarrying stone needed to complete the lock ed.

g the first fiscal year 1,035 cubic yards of dimension and back- were quaried and transported to the lock-site, and 459.77 cubic cut stone and 229.92 cubic yards of backing stone made ready ock-walls.

ork of improving the open-river navigation above the lock and confined to repairing the chute at Glenville, owing to the small of funds available.

rther details of the work done during the fiscal year reference o the annexed report of Mr. B. F. Thomas, the resident en-

timate of $51,800, as the amount required to complete the ap- project, is herewith renewed.

Money statement.

7, amount available		$7,784.93
8, amount expended during fiscal year, exclusive of s outstanding July 1, 1887	$7,420.66	
8, outstanding liabilities	30.00	
		7,450.66
8, balance available		334.27
propriated by act of August 11, 1888		25,000.00
ailable for fiscal year ending June 30, 1889		25,334.27
(estimated) required for completion of existing project		26,800.00
hat can be profitably expended in fiscal year ending June 30, 1890		26,800.00

d in compliance with requirements of sections 2 of river and acts of 1866 and 1867.

rcial statistics, Little Kanawha River, W. Va., for the fiscal year 1887–'88.

Articles.	Quantities.	Average price.	Value.
bushels	3,000	$0.60 per bushel	$1,800
cubic feet	1,852,000	.18 per cubic foot	333,360
feet, B. M.	4,777,700	30.00 per M feet	143,331
barrels	2,900	1.00 per barrel	2,900
number	336,940	.35 each	117,929
do	1,570,000	18.00 per M	28,260
cords	600	15.00 per cord	9,000
do	100	2.00 per cord	200
tons	100	100.00 per ton	10,000
xports			646,780
tons	1,000	100.00 per ton	100,000
xports and imports			746,780

enger traffic during the year was equivalent to 20,000 passengers through

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June* 30, 1888.

annual report for Little Kanawha River is herewith submitted.

ect contemplates the extension of slackwater navigation to the West Fork truction of a lock and dam 2 miles above Burning Springs, W. Va., and l of obstructions to navigation in the upper part of the river.

Below this new lock, the Little Kanawha Navigation Company have four locks a dams.

The work of quarrying the balance of the stone necessary for Lock No. 5, which begun just before the close of the last fiscal year was continued and completed, 831.23 cubic yards of dimension and 258.08 yards of backing stone were quarried delivered at lock-site.

The amount of money being somewhat limited, and the uncertainty of the cos quarrying being proven (owing to the irregularity existing in the ledges), it thought best to employ only a small force of stone-cutters. This proved very sa factory and 459.77 cubic yards of cut stone and 229.72 cubic yards of backing w made ready for the wall.

Owing to the fact that the navigation company had drawn off their pools to m repairs, we were unable to boat our stone to the lock, a distance of 5 miles, u after the close of the season's operations.

A contract was made with John F. King to do the boating at 35 cents per cu yard, the Government doing the loading and unloading by hired labor, and this w was done last February and March.

The cost of quarrying was $2,013.40 for 1,089.31 cubic yards; of cutting, $2,27 for 689.49 cubic yards; miscellaneous expenses for plant, superintendence, trans tation of derricks, tools, etc., $1,023.72.

It is desired, when money is available, to continue the cutting of stone and prep to complete the lock.

Nearly all the coping and many of the quoins are yet to be cut before we can much toward the building.

ABOVE WEST FORK.

The improvement of open river navigation on the upper river was, owing to small amount of money on hand, confined to the repairs of chute at Glenville. lower cross-timber was replaced and well fastened by inch spikes 4½ feet long, dri into the soft rock below. Twenty-five cubic yards of rock were broken in the ch before the sheeting was put down. About 8,000 feet, B. M., of lumber was put The river crib was refilled with stone and sheeted with 2-inch oak plank.

When there is money, there are still further repairs to be made at this chute, nota the head-gate.

I have been intelligently assisted both at lock and upon the upper river by faith overseers.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer

Capt. D. W. LOCKWOOD,
Corps of Engineers.

E E 6.

IMPROVEMENT OF BUCKHANNON RIVER, WEST VIRGINIA.

This river was under temporary charge of Lieut. Col. W. E. Merr Corps of Engineers, until April 13, 1888, since which time it has be under my charge.

The Buckhannon is one of the tributaries of Tygart's Valley Riv which, with the West Fork, forms the Monongahela. Its total leng from its headwaters to its junction with the Valley River is 57 mil The portion under improvement is the 24½ miles between the Th Forks, 10 miles below the headwaters, and the town of Buckhann and the object of improvement is to remove the obstruction to rafti in order to bring into market the immense quantity of fine timber the headwaters of this river.

Before any work of improvement was done the annual output of lo was about 100,000 linear feet. The maximum output of the most favo ble year was 115,000 linear feet.

Last year the product was 6,000,000 feet, B. M.

As the appropriation of August 5, 1886, was practically exhausted the close of the last fiscal year, no work has been done since.

ESTIMATE.

As there is yet much that might be done to improve the rafting capacity of this river, it is recommended that $5,000 be appropriated, as this sum can advantageously be expended during the next fiscal year.

Money statement.

July 1, 1887, amount available	$3.68
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3.68
Amount appropriated by act of August 11, 1888	1,500.00
Amount (estimated) required for completion of existing project	20,955.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics, Buckhannon River, West Virginia, for year ending June 30, 1888.

Articles.	Quantities.	Average price.	Value.
Logs.....feet, B. M..	6,000,000	$6 per M feet.	$36,000

E E 7.

PRELIMINARY EXAMINATION OF THE LOUISA (LEVISA) FORK OF SANDY RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 20, 1887.

GENERAL: In accordance with the instructions contained in Department letter of September 27, 1886, I have to submit the following report of the preliminary examination of the Louisa [Levisa] Fork of Sandy River, Virginia.

An examination and report upon this portion of the Levisa Fork of the Big Sandy River was submitted by Lieut. Col. W. E. Merrill, Corps of Engineers, in 1876, and printed in the Annual Report of the Chief of Engineers of that year, pages 140 to 146, Part II. The recent examination, made in compliance with the instructions received, confirms the facts ascertained and stated in the former report. It extended from the State line of Virginia to the mouth of Dismal Creek, a distance of 23 miles. This stream flows through a sparsely-settled country, in which the majority of the people are engaged in cutting and rafting logs. The only improvement asked for is the removal of trees, snags, and rocks, and the closing of duplicate channels, so that the logs can be brought to market without so great a risk and percentage of loss.

This stream is deemed worthy of improvement to this limited extent, which will only require the expenditure of a small amount. No additional survey is necessary. It is estimated that the cost of all the work to be done will probably not exceed $250 a mile, or a total of $5,750.

Any appropriation that is made, however small, can be advantageousl expended. The portion of the fork in Kentucky has already been im proved.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF THE LOUISA (LEVISA) FORK OF SANDY RIVER, VIRGINI.

UNITED STATES ENGINEER OFFICE,
Cincinnati, November 25, 1887.

SIR: I have the honor to submit the following final report on the su vey of "Louisa Fork of Sandy River, Virginia," ordered in the river an harbor act of August 5, 1886:

The Louisa Fork of the Big Sandy River may be considered as b ginning at the mouth of Dismal Creek, which is exactly 23 miles abov the line separating the States of Virginia and Kentucky. In this di tance the fall of the river is 328 feet, being at the rate of 14¼ feet pe mile. With such a fall it is evidently useless to attempt any improve ment other than the removal of obstructions.

The preliminary examination of this part of the Big Sandy River wa made in the latter part of 1886 by Mr. M. W. Venable, assistant enginee under the direction of my predecessor, Maj. James C. Post, Corps c Engineers, and the preliminary report was submitted by Major Post o January 20, 1887. In this report it is stated that the total cost of th needful work would not exceed $5,750, and that any less sum could b advantageously expended.

It will be observed that in his report to Major Post, which is here annexed, Mr. Venable states that this part of the Big Sandy River not worthy of improvement. I find on inquiry that this recommend tion was based on the fact that there is a stretch of 26 miles of riv between the Virginia State line and the mouth of Russell Fork, which nothing has as yet been done to improve rafting navigation, a as the writer considered himself limited by his instructions to the co sideration of the particular stretch which he was directed to examin he decided that he could not recommend the improvement of the upp part of a river while the lower part remained obstructed. Had t river been clear below the State line, Mr. Venable would have reco mended that the clearing-out process be extended to the mouth of t Dismal.

Believing that the removal of obstructions above the State line w inevitably cause the removal of those below it, I do not hesitate to su mit an estimate for improving this stretch of the Big Sandy River.

Mr. Venable states that he does not believe that the output of fore product will be much increased by the removal of obstructions, as t business is in the hands of a few men, who already handle as much ti ber as can be rafted during a season. It seems to me that this concl sion is not warranted by experience on other rivers, where increas facilities have always been followed by an increased output In m judgment, the small sums heretofore expended on the rafting rivers this section of the country have produced relatively larger returns th the vastly greater sums expended on rivers that are navigable by stea

boats; and I am decidedly in favor of the continuance of this policy within reasonable limits. The smaller streams that enter the Ohio from the Alleghany Mountains are not navigable, and can not be made navigable except for the inconsiderable commerce that is poled up in push-boats; but, on the other hand, their headwaters lie among forests of the finest timber within the United States, and, in view of the increased demand for timber, and the depletion of other sources of supply, it seems to me of the first importance to increase the facilities for bringing to market the vast supplies that lie on the western flanks of the Alleghanies. The lands that grow this timber are too steep for cultivation, and no damage will result from the periodical removal of the full-grown trees. The beds of the streams are more or less choked by huge bowlders that have fallen from the mountain sides, so that in many cases it is practically impossible to drive timber, even when there is an abundant supply of water. In my judgment, the removal of these bowlders and the general clearing up of the beds of the streams, so as to permit the free passage of logs whenever there is a supply of water, is a public benefit that fully justifies the very small outlay required to attain it. To assist in bringing this timber to market is to increase the national wealth, as otherwise a large part of this particular product will mature and decay without benefit to any one.

I therefore cordially concur in Major Post's recommendation that $5,750 be appropriated for the improvement of this part of the Louisa Fork of the Big Sandy River.

The output of timber for 1886, according to the report of Mr. Venable, hereto annexed, was 300,000 cubic feet, valued at $42,000.

For fuller details of the portion of the Big Sandy River lying between the mouth of Dismal Creek and Pikeville reference is made to my report of January 6, 1876, which may be found in the Report of the Chief of Engineers for 1876, Part II, page 140.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF M. W. VENABLE, ASSISTANT ENGINEER.

CINCINNATI, OHIO, *December* 17, 1886.

SIR: Under your letter of instructions of November 24, I made a preliminary examination of the Louisa Fork of Big Sandy River in Virginia, and beg leave to submit the following report:

The physical characteristics of the stream, its tributaries and the country through which they flow, have been well and fully described in the report of Maj. Wm. E. Merrill, January, 1876, to which I would respectfully refer you; so I shall only note the present condition and value of the stream as a means of transportation and an estimate of products now being shipped out by it.

My examination extended from the Virginia and Kentucky State line to the mouth of Dismal Creek, the largest tributary above Buchanan Court-House and the highest point up the stream from which rafting is practicable, a distance of 25½ miles. I find the stream a wild mountain torrent, full of shoals, rocks, and islands; pools of quiet water, few and short, and generally formed by small dams placed at the head of shoals, supplying power to the small grist-mills of the country. These dams are made of brush and stone (in some instances of timber), and vary in height from 1 to 3 feet. They all obstruct navigation by rafts more or less; but, on the other hand, furnish short pools of quiet water in which timber can be safely rafted and tied up awaiting the tides to take it out, so that any project for improving the stream should not include in the estimate the cost of removing these dams, except where they have been abandoned by their owners, but only the removal of rocks, and, where the stream has

divided into two or more channels, to confine it by dikes to the most direct and one.

I found on examination that there are thirty-seven points on the stream wher channel can be improved in this way at an average cost of $250 each, making a gregate cost of $9,250.

No improvement can make this stream available for purposes of navigation, ex for rafts and such forest products as can be rafted or floated out singly, such as cooper stuff, cross-ties, telegraph poles, hoop-poles, and forest products generally cept tan-bark).

The timber of this valley is of the finest quality, both oak and poplar, and the percentage of other woods; and as the lumbermen have, until recent years, con themselves to the tributary in Kentucky, the timber here is practically untou nothing but poplar and a few walnut logs having been sent out. The busin logging seems to be in the hands of only a few men, from whom, and also by a estimate, I learned that the output for this season will be 300,000 cubic feet, whi present market value will amount to $42,000. These men also state that, owi the hazardous navigation, they only take out the finest trees and those neares stream, whereas with the stream improved they could nearly double the produ much less than double the cost of labor, and risks proportionately reduced.

While the improvement of the stream would undoubtedly increase the market of the product by lessening its cost of transportation, I doubt if the annual o will be materially increased by it, owing to the fact that the available product the hands of a few men, who can only accomplish a certain amount of work in a season.

Owing to the rapidity of the stream, any work done on it might be of question or at best only of temporary, aid to navigation, and, in view of the limited comm importance of its products, and the small number of people to be benefited there consider the stream as unworthy of improvement, and do not consider any fu survey necessary.

Respectfully,

M. W. VENABLE,
Assistant Engin

Maj. JAS. C. POST,
Corps of Engineers.

E E 8.

PRELIMINARY EXAMINATION OF SALT RIVER, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 20, 188

GENERAL: In accordance with the instructions contained in letter of September 27, 1886, I have to submit the following repo the preliminary examination of Salt River, Kentucky.

Salt River drains an area of 2,765 square miles in the central por of Kentucky. It rises in the vicinity of Harrodsburgh, and flows n and west, emptying into the Ohio River 25 miles below Louisville. F its mouth to the entrance of the Rolling Fork, a distance of 12 mil is about 300 feet wide. Above this junction it is nearly 250 feet wid an additional distance of 14 miles, after which it divides into sev branches and becomes much smaller. In this examination the l and larger portion of the river was alone considered. This po flows through rich alluvial bottoms that are susceptible of high cul tion, and it is claimed by the inhabitants that the lack of suffi transportation greatly retards their development. Two steam-boa present navigate the river to Pitt's Point, at the mouth of Rolling F transporting freight to Louisville, the natural market of this sec and make trips as often as the height of water permits. The comm of this locality, as near as could be ascertained, amounted to $218,78 during the year ending December 31, 1886. (See inclosed statemen

From the information obtained it is believed that the lower po of the river, a distance of about 26 miles, is worthy of improvement

least it is worthy of an additional examination and survey, so that Congress may be fully advised concerning it.

It is estimated the cost of making the proper survey and preparing a project for its improvement will be $1,000.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

Commercial statistics of Salt River, Kentucky, for year ending December 31, 1886.

Articles.	Quantity.	Average price.	Value.
Apples ..... barrels..	1,250	$2.00 per barrel	$2,500.00
Corn ..... bushels..	15,510	.40 per bushel	6,204.00
Chickens ..... dozen..	1,500	2.00 per dozen	3,000.00
Hogs ..... head..	443	8.00 a head	3,544.00
Hoop-poles ..... number..	250,000	10.00 per M	25,000.00
Lumber ..... B. M. feet..	602,375	20.00 per M	12,047.50
Logs ..... number..	15,000	3.50 each	52,500.00
Merchandise (miscellaneous) ..... tons..	650	100.00 per ton	65,000.00
Passengers ..... number..	700	1.50 each	1,050.00
Straw ..... tons..	230	4.00 per ton	920.00
Hay ..... do....	850	14.00 per ton	11,900.00
Tan-bark ..... cords..	1,400	12.00 per cord	16,800.00
Tobacco ..... hogsheads..	33	100.00 per hogshead	3,300.00
Turkeys ..... number..	2,450	1.50 each	3,675.00
Potatoes ..... barrels..	560	2.00 per barrel	1,120.00
Wood ..... cords..	1,460	5.00 per cord	7,300.00
Wheat and oats ..... bushels..	3,250	.90 per bushel	2,925.00
Total	.....	.....	218,785.50

SURVEY OF SALT RIVER, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., February 9, 1888.

GENERAL: I have the honor to submit the following report on a survey of Salt River, Kentucky, made in accordance with the requirements of section 6, act of Congress approved August 5, 1886, and instructions from your office in letter dated March 16, 1887.

The survey was made by Mr. W. R. Curtis, assistant engineer, under the supervision of Lieut. W. L. Sibert, Corps of Engineers, U. S. Army, in October and November, 1887, under the favorable circumstance of exceedingly low water. The survey develops a good navigable depth of water in Salt River from its mouth, at West Point, on the Ohio, to Key's Ripple, a distance of 3.7 miles. From that point to Pitt's Point, a distance of 8.2 miles, there are stretches of good water, alternating with shoals, and in the upper part of the reach shallow water, with many obstructions caused by snags and drift.

The line of levels shows that the river above Key's Ripple can be made navigable by the construction of a lock and dam at that ripple, with a lift of 10 feet as follows: To Pitt's Point, a distance of 8.2 miles, with a least depth of 5 feet. From Pitt's Point, 3 miles further up Salt River and 2 miles up Rolling Fork, with a least depth of 2.5 feet.

The cost of a lock and dam and some work of removing obstructions is estimated at $175,000. The accompanying tables of commercial statistics and probable amount of commerce that would be benefited by the

improvement would appear to justify the work, which would tend develop a rich portion of country.

Copies of the reports of Lieut. W. L. Sibert, Corps of Engineers, a Mr. W. R. Curtis, assistant engineer, are appended. Map of the surv is sent in separate package.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, February 2, 1888.

SIR: I have the honor to submit the following report of a survey of Salt Rive Kentucky. The survey was made by W. R. Curtis, assistant engineer, whose r port and map are inclosed. Salt River drains about 2,700 square miles. It rises Burke County, and flows in a northwestern direction, and empties into the Ohio miles below Louisville, Ky. The stage of the water in Salt River and in the Oh when the survey was made, was the lowest known for years. From the map it w be seen that over 6 feet of water exists from the mouth to Key's Ripple, a distance 3.7 miles. After crossing this ripple there is good water for 1.8 miles; the remaind of the river to Pitt's Point and above is shoal and full of snags. The banks a high. The river at this low stage averages about 160 feet in width. The total f of the river from its mouth to Pitt's Point is 2.7 feet. The fall from Pitt's Point Key's Ripple is about 2.5 feet. The slope of the river from Pitt's Point up, and the Rolling Fork, is quite steep. I had a line of levels run up these branches to certain how far a dam raising low-water level 10 feet at Key's Ripple would give feet of water; Mr. Curtis reports 2 miles up Rolling Fork and 3 miles up Salt Riv and that an increase in the height of the dam would extend the pool a very short d tance on account of the steep slope of the river. From the reports of both the exa ination and survey of this river it appears that the lower portion of Salt River flo through a very fertile country, at present only partially developed on account of want of transportation. Louisville, Ky., is the natural market for this section.

The inclosed commercial statistics and the estimated amount of commerce t would be benefited by improving the lower river seems to justify an appropriation its improvement.

I would recommend that a lock and dam be placed in the river near Key's Ripp as indicated on the drawing. A dam raising low-water level 10 feet at Key's Rip would give over 5 feet at Pitt's Point, 8.2 miles distant, and 2.5 feet for 3 mi further up the river, and 2.5 feet for 2 miles up the Rolling Fork (which empties i the Salt at Pitt's Point), making a pool of over 13 miles. Also that the snags a projecting rock be moved from the channel.

It is estimated that $175,000 will complete the projected improvement on this riv

Very respectfully, your obedient servant.

WM. L. SIBERT,
Second Lieutenant of Engineer

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

REPORT OF MR. W. R. CURTIS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., January 23, 188

LIEUTENANT: I have the honor to submit the following report of a survey of S River, Kentucky, made in compliance with your instructions.

Salt River rises in Burke County, Ky., flows through Mercer, Nelson, and Washi ton counties, and dividing Bullitt and Hardin counties, empties into the Ohio Ri at West Point, about 22 miles below Louisville, Ky.

Field work was commenced in October and completed in November, 1887. A tr sit line was run from West Point to Pitt's Point, 11.9 miles above, where the Roll Fork empties into Salt River, the distances being determined by stadia measureme

A line of levels was run over the same points and carefully checked, and bench-marks established at prominent points along the line. These bench-marks and levels were referred to the zero of a gauge which was established on the center pier of the railroad bridge at West Point.

The stage of the Ohio and Salt rivers at the time of the survey was the lowest known for many years and corresponded to a reading of 1.8 feet in this gauge. Soundings taken at each station were referred to this low-water stage.

From the mouth of Salt River to the first shoal of Key's Ripple, 3.7 miles above, there is better water than in the Ohio, and any boat that can run on the Ohio can pass up Salt River to this shoal without trouble, except at West Point, where the N. N. and M. V. R. R. Co. have put in trestling on each side of the draw-pier, which is in a bad condition, and at low water these trestles form an obstruction. Key's Ripple Shoal is at the foot of a high, rocky bluff and extends entirely across the river; it is about 120 yards long and has less than one-tenth foot fall between the pools.

Above this shoal there is good water to Mill Creek Ripple, 1.8 miles above. From Mill Creek to Pitt's Points the river is very shoal and full of snags and drift, the last mile beir g impassable.

The banks of the river average from 20 to 30 feet in height and the bottom lands are said to be very rich, being subject to overflow by backwater from the Ohio River and its own extensive water-shed. The bed of the river is composed of a very tenacious and soft black mud, except at the points where the bluffs approach the banks.

The slope of the river is less than five-tenths foot in the first 9 miles, and there is very little current over the shoals; the total fall from Pitt's Point to the mouth is 2.7 feet. (A survey made by the State some years ago gave this fall 3 feet.) Above Pitt's Point the slope is greater, but less on Salt River than on the Rolling Fork.

A lock and dam placed at the foot of Key's Ripple, raising the low-water level of the pool above 10 feet, would give 5 feet of water up to Pitt's Point and 2.5 feet for 2 miles up the Rolling Fork, and 3 miles up Salt River above Pitt's Point, making a pool of 13 miles in length.

This river is subject to high freshets and the backwater from freshets in the Ohio River. On February 18, 1883, the water covered the business portion of Pitt's Point, reaching a height of 73.6 feet. The freshet of 1884 was eight-tenths higher, or 74.4 feet. At this time the Ohio River at West Point was up to 74.5 feet.

A map of Salt River from Pitt's Point to the mouth at West Point, with profile of the low-water slope level of proposed pool and approximate bed of river, accompanies this report.

Respectfully submitted.

W. R. CURTIS,
Assistant Engineer.

Lieut. W. L. SIBERT,
Corps of Engineers, U. S. A.

Probable amount of commerce to be benefited by the improvement of Salt River, Kentucky.

Articles.	Quantity.	Average price.	Value
Hay ..... tons..	2,500	$14.00 per ton	$35,000.00
Straw ..... do....	300	4.00 per ton	1,200.00
Oats (baled) ..... do....	200	20.00 per ton	4,000.00
Corn ..... bushels..	100,000	.40 per bushel..	40,000.00
Oats (shelled) ..... do....	50,000	.32 per bushel..	16,000.00
Wheat ..... do....	20,000	.90 per bushel..	18,000.00
Apples ..... barrels..	8,000	2.00 per barrel..	16,000.00
Potatoes ..... do....	1,000	2.00 per barrel..	2,000.00
Lumber, B. M ..... feet..	1,000,000	20.00 per M	20,000.00
Wood ..... cords..	20,000	5.00 per cord....	100,000.00
Hoop-poles ..... number..	300,000	10.00 per M	3,000.00
Tan-bark ..... cords..	5,000	12.00 per cord....	60,000.00
Hogs ..... head..	10,000	8.00 per head	80,000.00
Cattle ..... do....	500	40.00 per head ...	20,000.00
Sheep ..... do....	3,000	3.50 per head ...	10,500.00
Turkeys ..... number..	5,000	1.50 each.....	7,500.00
Chickens ..... dozen..	3,000	2.00 per dozen...	6,000.00
			439,200.00

APPENDIX F F.

IMPROVEMENT OF THE HARBOR AT DULUTH, MINNESOTA, AND AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN—IMPROVEMENT OF THE HARBORS AT GRAND MARAIS AND AGATE BAY, MINNESOTA.

REPORT OF CAPTAIN JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Duluth, Minnesota.
2. Harbor at Superior Bay and St. Louis Bay, Wisconsin.
3. Harbor at Agate Bay, Minnesota.
4. Harbor at Grand Marais, Minnesota.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., June 30, 1888.

GENERAL: I have the honor to transmit herewith annual reports upon works of river and harbor improvement at present in my charge, for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

FF 1.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

The location of Duluth Harbor is exceedingly favorable for its economical maintenance, and also for the ease with which vessels can enter it under all conditions of weather.

The anchorage area is generally free of ice sometime before the ice outside will permit vessels to approach the head of the lake, and the docks are therefore in complete readiness for the accommodation of commerce upon the opening of navigation. As a general rule I believe that vessel can make Duluth Harbor whenever the entrance to the lake is possible, and usually the harbor and lake outside are not frozen over in the winter until sometime after the Sault Canal is closed.

Previous to the construction of the Duluth Canal a good deal of mo was expended in the efforts to create a harbor in the lake east of M nesota Point, but before the breakwater could be completed or prope secured an extraordinarily severe storm destroyed the work. The ca between Lake Superior and Superior Bay had been partially comple by the citizens of Duluth at the time of the severe storm, and it a received considerable damage. The citizens of Duluth, not feeling a to repair the damage to the canal, requested the United States to sume control, since which time the Government has made such tem rary repairs as from time to time became necessary, but no compreh sive plan of improvement has been advocated, for the principal rea that the title to the canal was never legally transferred to the Uni States.

The chamber of commerce, which is composed of the principal bu ness men of the city, recognized the importance of the United Sta having undisputed possession of this canal, and proceeded to ma suitable disposition to secure this object. The titles to the land cove by the canal were secured, not however in some cases without cons erable personal outlay on the part of some loyal citizens, and a de was finally perfected in which this valuable property is presented the United States by the city of Duluth. This deed is dated Janu 9, 1888.

Owing to lack of funds the necessary survey and elaboration of p ject for its permanent improvement have not been completed.

When the Duluth Canal was commenced few of the lake ports h depths of over 12 feet, and 14 feet depth was adopted for the canal being as great as would probably be required. Since then the draug of lake vessels has reached 16 feet, and in a short time will be increas to 20 feet. The piers, which were originally intended for but 14 f depth of water in the channel between them, and withal of not ve substantial construction, have been obliged to serve for a 16-foot ch nel. I think it needs no argument to establish the fact that, withc seriously obstructing the channel with riprapping or other protecti of a make-shift character, these piers can hardly be made to answer a channel with sufficient depth to admit boats of 20 feet draught. Ju what the cost of reconstructing and extending these piers will be purely a matter of conjecture until the completion of the plans, et but it will not be far from $500,000, part of which is chargeable to t removal of present piers. This seems like a large sum, but since expenditure would extend over a number of years it would bear bu small ratio to the value of the benefits which would result to the co merce which would enter the Duluth harbor during the time the i provement was in progress, to say nothing whatever of the subseque benefits while the works endured.

To maintain the present piers in fairly serviceable condition unti project for their replacement is perfected will require an average ann outlay of $10,000. The cribs and superstructure are in a rather decre state and are liable in consequence to extensive damage by a sev storm.

The submerged crib at the outer end of the south pier, which w put in last season, has stood very well. The upper course and the de ing have been knocked off by log rafts and the ice, but its efficiency slightly, if at all, impaired. The 240 feet of the inner end of the nor pier is, as the result of the repairs of last season, practically new. is simply a temporary structure of wood.

THE HARBOR BASIN

has been increased in size, both by Government and private dredging, until it contains about 126 acres. Ultimately this will have to be deepened to 20 feet. For general purposes the area dredged by the United States is sufficient for present needs.

It is important, however, that channels be dredged connecting this area with other areas controlled by the United States, and of these needed channels the one east of Rice's Point is of chief importance. This channel was alluded to in my last annual report. It will cost to complete it $119,552, as previously estimated.

Several important private interests are held in abeyance, pending its completion, and its early completion is anxiously awaited by the vessel-owners who have business at the docks in West Superior or St. Louis Bay.

NORTH SHORE CHANNEL, ST. LOUIS BAY.

The occupation of the greater part of the dockage area bordering the harbor of Duluth for miscellaneous commercial purposes compelled those manufacturing enterprises requiring dock facilities to locate on the north shore of St. Louis Bay and at Grassy Point. At Grassy Point there is now a steam forge in successful operation, and the preparation of the site for a large steel blast-furnace is nearly completed. Other manufacturing enterprises are expected to locate here soon.

If this improvement is possible, with the shallow channel at present existing between Grassy Point and the lake, it is difficult to predict what the magnitude of the manufacturing interests of this locality will be when a suitable channel is completed along the north shore of St. Louis Bay. This channel was recommended as being worthy of improvement by the United States in my last annual report.

A 200-foot channel was estimated to cost $163,000. A channel 100 feet wide could be most economically excavated in one year. This would cost $82,000. Such a channel would be rather narrow, but would answer for a year or so, until it could be enlarged. This channel is intended to be but 16 feet deep, or to have the same depth as the dredged areas and channels hitherto completed by the United States. It is within the range of possibilities that this channel and all the other dredged areas will have to be deepened to 20 or possibly 22 feet. No estimate is made, however, to cover this expected deepening. It will be considered later.

It would contribute very much to the safety of vessels and preservation of the dredged channels if some system of range beacons, or other permanent means of marking the channels, was adopted. The buoys planted last season have nearly all been carried off by the ice or log rafts. At least $500 will be needed to establish these beacons in Duluth Harbor the ensuing year.

Work during the fiscal year just closed was as follows: Williams, Upham & Co. continued dredging from July 1 to September 17, inclusive, under contract dated April 16, 1887. The dredging consisted in enlarging the harbor basin to the southward. The amount of material excavated was 159,940.35 cubic yards.

Charles S. Barker completed general repairs to the north and south piers of canal September 21, under contract of April 19, 1887, the contract price being $7,800. Repairs to the outer end of south pier, under contract of June 24, were completed September 15, at a cost of $2,950.

CONDITION OF THE IMPROVEMENT.

The piers are in fair condition, but the superstructure and perhap the entire work will eventually require to be replaced with more durab material. The following are ruling depths in the portions of the harb dredged by the United States:

	Fe
In canal	
In the inner basin or harbor	
In Blast Furnace Channel to a point opposite Elevator E	
From point opposite Elevator E, through dredged channel along east side of Rice's Point to the St. Louis River	

The areas and channels above mentioned (canal and anchorage ar excepted) require widening.

The dredged area of harbor basin comprises about 104 acres, exc sive of private dredging, and has a minimum depth of 16 feet.

Résumé of recommendations.

For maintenance of canal piers	$10,
For channel on east side of Rice's Point	119,
For channel 100 feet wide on north shore of St. Louis Bay	82,
For beacons for marking channels	
Total	212,

This work is in the collection district of Duluth, Minn. Duluth, Minn., is nearest port of entry. The nearest light-house is situated on the south pier of Dul Canal, Minn.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT DULUTH, MINNESOT

By act of Congress approved March 3, 1871	$60,000
By act of Congress approved June 10, 1872	50,000
Allotted from act approved March 3, 1873	36,049
By act of Congress approved June 23, 1874	10,000
By act of Congress approved March 3, 1875	35,000
By act of Congress approved August 14, 1876	15,000
By act of Congress approved June 18, 1878	30,000
By act of Congress approved March 3, 1879	25,000
By act of Congress approved June 14, 1880	25,000
By act of Congress approved March 3, 1881	40,000
By act of Congress passed August 2, 1882	45,000
By act of Congress approved July 5, 1884	45,000
By act of Congress approved August 5, 1886	56,250
Total	472,299

The following statement shows the manner in which the appropr tions have been expended. The amount expended under the differe classes of work includes the cost of soundings, superintendence, bu ing, and contingencies:

Class of work.	To June 30, 1888.	Prior to present project.	Unde present p ject to Ju 30, 1888
Breakwater	$110,000.00	$110,000.00	.....
Canal piers, etc	76,967.86	45,686.33	$31,26
Dredging	281,304.30	114,953.48	166,35
Reserved by Chief of Engineers	227.90	.....	22
Total	468,500.06	270,651.81	197,84

*Adopted in 1881.

Estimate for carrying out present project, adopted in 1881	$212,988.36
Increased cost, for reasons stated in annual report of Maj. Charles J. Allen for 1884	92,435.64
Total	305,424.00
Amount appropriated under present project	186,250.00
Balance required for present project	119,174.00
Additional amount required for new work	285,352.00
Total required for extended project	404,526.00
Amount required annually for preserving and maintaining	10,000.00

Money statement.

July 1, 1887, amount available	*$42,415.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	38,615.92
July 1, 1888, balance available	3,799.14
Amount appropriated by act of August 11, 1888	80,000.00
Amount available for fiscal year ending June 30, 1889	83,799.14

Amount (estimated) required for completion of existing project	324,526.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	212,052.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels for 1886 *and* 1887.

Years.	Vessels.	Tonnage.	Average tonnage.
1887	2,475	2,021,789	812
1886	2,021	1,569,068	776
Increase	454	452,721	36

Comparative statement of arrivals and clearances of vessels at Duluth for eleven years.

Years.	Arrivals.	Clearances.	Total.	Years.	Arrivals.	Clearances.	Total.
1877	329	328	657	1883	796	779	1,575
1878	406	343	749	1884	888	903	1,791
1879	502	497	999	1885	898	899	1,797
1880	594	524	1,048	1886	1,026	995	2,021
1881	666	660	1,326	1887	1,237	1,238	2,475
1882	833	832	1,665				

Value of exports from Duluth.

1887	$3,888,138
1886	2,419,847
Increase	1,468,278

* The outstanding liabilities of July 1, 1887, were reported as $1,107.58 in last Annual Report; the amount should have been $1,103.44.

The "in transit" trade.

Years.	Value of merchandise.	Duties.
1887	$82,415	$52,205.4[redacted]
1886	94,549	52,576.9[redacted]7
1885	96,385	46,971.1[redacted]1

Merchandise entered for warehousing, 1887	$11,317.[redacted]0
Duty on same	3,784.[redacted]57
Value of free goods	128,658.[redacted]00
Dutiable goods	20,357.[redacted]00
Duties collected	5,386.[redacted]74

Receipts of flour for shipment eastward.

	Barre[redacted]ls.
1885	1,076,[redacted]044
1886	1,483,[redacted]570
1887	1,800,[redacted]000

Coal receipts in 1887.

	To[redacted]ns.
At Duluth	626,[redacted]000
At West Superior	415,[redacted]000
Total	1,041,[redacted]000
Receipts in 1886	736,[redacted]000
Increase	305,[redacted]000

Grain shipments by lake.

Years.	Wheat.	Corn.	Oats.	Barley.	Total[redacted].
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushe[redacted]ls.*
1887	19,518,586	132,553	31,365	19,273	19,701[redacted],777
1886	17,668,251	121,871	500	21,407	17,812[redacted],029
Increase	1,850,335	10,682	30,865	.....	1,889[redacted],748
Decrease	.....	.....	.....	2,134	.....

The storage capacity of Duluth elevators is 19,550,000 bushels.

The following table gives the receipts and shipments of wheat for seventeen years at Duluth:

Years.	Receipts.	Shipme[redacted]ents.
Year ending December 31—	*Bushels.*	*Bush[redacted]els.*
1887	17,136,275	19,518[redacted]8,586
1886	22,532,574	17,668[redacted]68,251
1885	14,869,675	14,065[redacted]65,775
1884	13,722,930	11,551[redacted]1,562
Year ending August 31—		
1883	4,707,803	4,586[redacted]86,900
1882	3,266,242	3,325[redacted]25,490
1881	3,332,176	2,865[redacted]65,534
1880	1,347,679	1,453[redacted]53,674
1879	1,524,065	1,487[redacted]87,222
1878	1,803,090	1,782[redacted]82,358
1877	460,595	503[redacted]03,809
1876	1,451,190	1,376[redacted]76,302
1875	1,137,721	1,081[redacted]1,194
1874	2,407,476	2,42[redacted]4,170
1873	1,981,453	1,58[redacted]3,173
1872	931,611	95[redacted],046
1871	556,783	54[redacted]848

Opening and closing of navigation.

Years.	Opening.	Closing.
1885	April 27	November 29.
1886	May 7	December 14.
1887	May 4	December 28.
1888, first boat arrived	May 11	

NOTE.—The dates of opening and closing of navigation by years, 1865–'84, are given in Annual Report of the Chief of Engineers for 1885.

F F 2.

IMPROVEMENT OF HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

The piers of the natural entry to Superior Bay now aggregate 5,650 feet in length.

They have received but little attention in the way of repairs for several years, and are in a more or less decrepit condition, and consequently liable to extensive damages by the first severe storm; the money allotted for their repairs is inadequate for other use than a reserve fund to repair such damages as may result from storms, and the needed general repairs are perforce postponed until sufficient funds can be secured to carry the work to a successful conclusion when undertaken. An appropriation of at least $25,000 is required to meet the necessities of this work for the ensuing year.

At present the channel of the entry and the bay is of sufficient depth to accommodate the vessels visiting this port, but the channel is rather narrow and tortuous, and at the present moment two large vessels are aground in consequence of getting out of the channel. A good deal of dredging is needed to strengthen this channel; and furthermore it should be permanently marked by beacons of sufficient stability to withstand the ice and collision of rafts. The dredging will cost $20,000, and the beacons about $500.

The Nemadji River flows into Superior Bay very near the inner extremity of the entry piers. A large portion of the detritus is deposited over the area dredged out in front of Quebec Dock and in the main ship-channel. At present the Nemadji is at its flood stage, and it is impossible to say just what the extent of the deposits due to it will be. It is quite likely that some dredging will be necessary to keep the main ship-channel in passable condition as soon as the high water subsides; also to open the channel through the bar that will form at the river's mouth. This will probably cost not less than $5,000. In view of the fact that this possible annual interruption to the navigation of the main ship-channel on account of the location of the mouth of the Nemadji River is increasing, since the floods of the river carry more and more sediment by reason of the clearing off of the timber lining its banks, it seems that prudence requires the early deflection of this river so that it will flow into Allouez Bay and be allowed to deposit its bar-building material where it will cause no damage to important navigable channels. In the absence of a special survey to determine the cost of this change in the mouth of the Nemadji, I am unable to give any estimates of cost. I think a suitable survey to determine this information might be made for not to exceed $500.

CHANNEL ALONG WISCONSIN DOCK-LINE, ST. LOUIS BAY.

The completion of the channel along the Wisconsin Dock-line, Louis Bay, will cost $112,156. This amount could be advantageou expended in one year.

Work during the fiscal year just closed has been as follows: Dre ing was continued by Charles S. Barker, under contract dated Dec ber 21, 1886, from July 1 to August 19, inclusive, the following amo of material having been removed, viz:

	Cubic y
Dredging in St. Louis Bay, along the dock-line on the Wisconsin shore, between Connor's Point and Grassy Point	12,
Deepening and enlarging channels in Superior Bay and Harbor, including the mouth of the Nemadji River	19,
Total	32,

CONDITION OF THE IMPROVEMENT.

The entry piers are in fair condition, but need extensive repairs, p ticularly the superstructure, to render them secure. The beach p tection is still intact.

The ruling depths in the channels dredged by the United States ar

	F
From Connor's Point to the entry	
From Northern Pacific Railroad Dock to the entry	
In front of Quebec Dock	
Throughout the entry between piers	

Résumé of recommendations.

For general repairs to the entry piers	$25,
For straightening and widening channel in Superior Bay	20,
For beacons for marking channel	
For dredging at mouth of the Nemadji River and vicinity	5,
For survey to determine cost of deflecting channel of Nemadji River	
For completion of channel along Wisconsin dock line, St. Louis Bay	112,
Total	163

Superior, West Superior, and Connor's Point are in the collection district of S rior, Wis.; Marquette, Mich., being the port of entry. The nearest light-hous situated on the entry piers at Superior, Wis.

Abstract of appropriations for improving harbor at Superior Bay and St. Louis Bay, consin.

By act of Congress approved March 3, 1867	$63,00
By act of Congress approved April 10, 1869	45,00
By act of Congress approved July 7, 1870	40,00
By act of Congress approved March 3, 1871	60,00
By act of Congress approved June 10, 1872	50,00
Allotted from act approved March 3, 1873	63,95
Allotted from appropriation for "repairs of harbors on northern lakes"	5,43
By act of Congress approved August 14, 1876	3,00
By act of Congress approved June 18, 1878	3,00
By act of Congress approved March 3, 1879	5,00
By act of Congress approved June 14, 1880	5,00
By act of Congress approved March 3, 1881	10,00
By act of Congress passed August 2, 1882	40,00
By act of Congress approved July 5, 1884	45,00
By act of Congress approved August 5, 1886	22,500
	460,83

Expenditures.

Amount expended under original project, adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1888	115,095.91
Reserved by Chief of Engineers	4.30
Total	450,613.47

Estimates.

Estimate for carrying out present project, adopted in 1881	312,080.00
Act of July 5, 1884, added improvement of the St. Louis River Channel within the bay of Superior, the estimated cost of which was (see annual report of Maj. Charles J. Allen for 1885)	33,000.00
Estimated cost of present project	345,080.00
Appropriated under present project	117,500.00
Balance required for present project	227,580.00
Additional amount required for new work (see Annual Report for 1887)	114,156.00
Total required for extended project	341,736.00

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Repairs and beach protection	$13,233.00
Construction and repairs to piers	318,173.53
Dredging	119,202.64
Reserved by Chief of Engineers	4.30
Total	450,613.47
Estimated amount required annually for preserving and maintaining	10,000.00

Money statement.

July 1, 1887, amount available	*$18,768.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,497.78
July 1, 1888, balance available	10,270.33
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	60,270.33
Amount (estimated) required for completion of existing project	291,736.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	63,156.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels for 1887.

Description.	Number.	Tonnage.
Steamers	286	300,414
Schooners	176	110,424
Total	462	410,838

*The amount expended in previous fiscal year, with liabilities added, should have been $7,081, instead of $6,774.53.

Shipments of freight by lake

Commodities.	
Bricks	
Wheat	
Total	

Comparative statement of receipts and sh

Years.	Value.	
1887	$4,725,514	1885
1886	3,253,248	1884

Comparative statement of arrivals and clearance

Years.	Vessels.	Tonnage.	
1887	462	410,838	1884
1886	316	271,190	1883
1885	200	189,768	

F F 3.

IMPROVEMENT OF HARBOR AT AGAT

Agate Bay is a small indentation of the no and in an unimproved state could afford b during storms. Nevertheless, the little shelt to cause its selection as a place of shipment the Vermillion range, and a railroad has be harbor and Tower to the

ing. The beneficial effect of the portion already built is quite apparent, and the completion of this pier will undoubtedly be of very great benefit to commerce, aside from the local necessities of the place, since it will provide a much-needed harbor of refuge east of Duluth for vessels caught in storms which would render the entrance to Duluth Harbor risky.

It is hardly possible that the piers can be built, under the most favorable circumstances, in time to prevent more or less inconvenience to local commercial interests if the increase in the amounts of ore shipped and merchandise received continues as heretofore at this place.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the south pier of Duluth Canal, Minnesota.

Abstract of appropriations for improving harbor at Agate Bay, Minnesota.

By act of Congress approved August 5, 1886	$22,500.00

Expenditures.

Amount expended under approved project to June 30, 1888	$20,588.34
Reserved by Chief of Engineers	94.60
Balance available July 1, 1888	1,817.06
	22,500.00

Estimates.

Estimated amount required to complete the improvement	$221,708.00
Estimated amount required annually for preserving and maintaining, when improvement is completed	2,000,00

Money statement.

July 1, 1887, amount available	*$21,521.47
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,704.41
July 1, 1888, balance available	1,817.06
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,817.06
Amount (estimated) required for completion of existing project	206,708.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	77,500.00

Submited in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS OF TWO HARBORS, AGATE BAY, MINNESOTA.

Number of vessels arriving and departing.

Year.	Vessels.	Tonnage.
1885	†174	295,800
1886	†263	460,000
1887	465	697,500

*The outstanding liabilities July 1, 1887, were reported as $120 in last annual report; the amount should have been $125.25.

† In addition to these were numerous north shore and other boats, and daily boats between Duluth and Two Harbors, not included in this statement.

Receipts and shipments.

	1885.	1886.	188
	Tons.	*Tons.*	*Ton*
Ore shipped	225, 484	304, 396	39
Miscellaneous freight received and shipped	10, 895	21, 954	
Total	236, 379	326, 350	40

Estimated value of freight received and shipped, exclusive of ore.

1885	$497,
1886	773,
1887	96,

F F 4.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

This harbor has a location which renders it particularly important a harbor of refuge, and its importance in this respect is increasing y by year as the commerce which passes by it grows and comes nea to it on the route to Duluth, 110 miles to the westward. It bids f to become an important shipping point shortly, as arrangements already about perfected which have for their object the erection of tensive ore docks at this place, and the construction of a short line railroad to the extensive deposits of iron ore and other minerals bu short distance inland.

The focusing of so much business at this place, as is exceedin probable within a very short time, will require a very considerable tension of the harbor improvements at present in progress. It will necessary to dredge out the entire area of the harbor within the 5-f curve, and to lengthen the breakwater pier about 350 feet.

At ruling prices this will necessitate an expenditure of $165,475, cluding contingencies, if the work is completed in one year; but if su appropriations only are received from year to year this estimate wil too small by reason of the extra expense incurred through unavoida damages to work in progress, and transportation of plant to and from year to year.

During the past season operations were confined to dredging, and area suitable for the anchorage of vessels of not over 16 feet draught been increased to 11 acres. The pier is in good condition and will quire scarcely any repairs.

For more detailed description of this harbor attention is invited my annual report for fiscal year ending June 30, 1887.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is nearest port of entry. The nearest light-house is situated on the breakwater at G Marais.

Abstract of appropriations for improving harbor at Grand Marais, Minn.

By act of Congress approved March 1, 1879	$1C
By act of Congress approved June 14, 1880	1C
By act of Congress approved March 3, 1881	2C
By act of Congress passed August 2, 1882	2C
By act of Congress approved July 5, 1884	1C
By act of Congress approved August 5, 1886	1C
Total	60,

Expenditures.

Amount expended under approved project to June 30, 1888	$77,577.77
Balance available July 1, 1888	2,422.23
	80,000.00

Estimates.

Original (estimated) amount required to complete the improvement	$139,669.00
Present (estimated) cost to complete the improvement in accordance with extension of project, exclusive of amounts already appropriated, for reasons stated in my annual report for 1887	165,475.00
Estimated amount required annually for preserving and maintaining	1,500.00

Money statement.

July 1, 1887, amount available	*$5,643.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,220.96
July 1, 1888, balance available	2,422.23
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	17,422.23
Amount (estimated) required for completion of existing project	150,475.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,475.00

Submitted in compliance with requirements of sections 2 of the river harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR YEAR 1887.

Arrival of vessels	164
Clearances of vessels	164
Total	328

	Pounds.	Value.
Freight received	462,593	$23,847.74
Freight shipped		5,212.17

Freight received and shipped for seven years.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1881	362,000	$30,293.00	1885	583,366	$41,484.86
1882	500,000	25,691.70	1886	784,750	48,519.60
1883	398,513	27,575.04	1887		29,059.91
1884	265,259	30,198.76			

Arrivals and clearances of vessels for seven years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1881	108	108	1885	188	190
1882	134	134	1886	210	210
1883	131	131	1887	164	164
1884	152	158			

*The outstanding liabilities July 1, 1887, were reported as $5,917.67 in last annual report; the amount should have been $5,922.21.

APPENDIX G G.

RS ON LAKE SUPERIOR (EAST OF SUPERIOR CITY), ON GREEN AND ON THE WESTERN SHORE OF LAKE MICHIGAN, NORTH OF 'AUKEE, WISCONSIN.

T OF MAJOR CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS, CER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

nd Harbor, Wisconsin.
nagon Harbor, Michigan.
Harbor, Michigan.
lishment and maintenance of oor-lines in Portage Lake, Michi-
nette Harbor, Michigan.
or of Refuge, Grand Marais, Mich-
stique Harbor, Michigan.
River Harbor, Michigan.
monee Harbor, Michigan and consin.
10. Oconto Harbor, Wisconsin.
11. Pensaukee Harbor, Wisconsin.
12. Green Bay Harbor, Wisconsin.
13. Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.
14. Ahnapee Harbor, Wisconsin.
15. Kawaunee Harbor, Wisconsin.
16. Two Rivers Harbor, Wisconsin.
17. Manitowoc Harbor, Wisconsin.
18. Sheboygan Harbor, Wisconsin.
19. Port Washington Harbor, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 6, 1888.

I have the honor to transmit herewith annual reports for the of river and harbor improvement in my charge for the fiscal year June 30, 1888.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

CHIEF OF ENGINEERS, U. S. A.

G G 1.

IMPROVEMENT OF ASHLAND HARBOR, WISCONSIN.

t.—To preserve Chequamagon Point and to provide a channel in f the city wharves of Ashland sufficient for vessels drawing 16 water.

ct.—The project submitted and approved was to close the breach quamagon Point by a pile revetment about 4,300 feet long, and

then to dredge a channel 100 feet wide and 18 feet deep in front a touching the principal wharves of the city, with a semicircular turni basin of 400 feet radius.

Present works.—In accordance with the above plan, bids were solici by advertisement dated November 19, 1887, for constructing 4,300 f of pile revetment across the breach at Chequamagon Point.

Great opposition on the part of the people of Ashland was ma fested against closing the breach, and a petition of the Business Me Association, numerously signed, was sent to the Secretary of W protesting against the closure of the breach, recommending that opening be protected against being enlarged; also recommending dre ing in front of the dock-line, and urgently favoring the building o breakwater, though this breakwater had not been recommended by Board of Engineers of March, 1887, and had formed no part of the proved plan.

In consequence of this protest, work was ordered suspended Nove ber 23, 1887, before the time for opening the bids, and since then nothi further has been done.

Original estimate for existing project	$88,
Appropriated	22,

Money statement.

July 1, 1887, amount available	$21, 82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	82
July 1, 1888, balance available	20, 99
Amount appropriated by act of August 11, 1888	60, 00
Amount available for fiscal year ending June 30, 1889	80, 99
Amount (estimated) required for completion of existing project	1, 04
Amount that can be profitably expended in fiscal year ending June 30, 1890	1, 04

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDER YEAR 1887.

[Furnished by C. H. Call, collector of customs.]

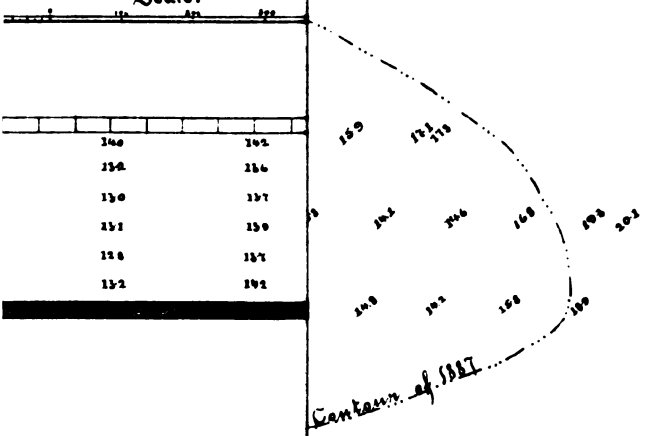
Name of harbor, Ashland, Wis.; collection district, Superior, Mich.; nearest li house, La Point, on Chequamagon Point, at entrance of Chequamagon Bay.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures	
	Number.	Tonnage.	Number.	Ton
Steam	170	159, 252	170	15
Sail	276	165, 920	276	16
Total	446	325, 172	446	32

Map
of
gon Harbor
Lake Superior
Prior Construction up to date a
annual in 1887

Scale.



To accompany my annual report
fiscal year ending June 30, 1888.

Chas. E. L. B. Davis
Major of Engineers.

The advance of the bar, referred
continues, the soundings of 1887 s
that an additional extension of both
18-foot contour. This pier extensio
mended, will materially increase the

Statement of materials and their cost in place
W. T. Casgrain, contractor, in the constructi
100 *feet of superstructure.*

14,908 linear feet pine timber, 12 by 12 and 1
590 linear feet hemlock timber, 12 by 12 and 1
12,763 feet B. M. pine plank, at $25 per M ....
12,522 pounds drift-bolts, at 4½ cents.....
3,135 pounds screw-bolts, at 6 cents.....
676 pounds spikes, at 4 cents.....
469.7 cords stone, at $10.....
Removing and relaying 2,670 feet B. M. pine pl

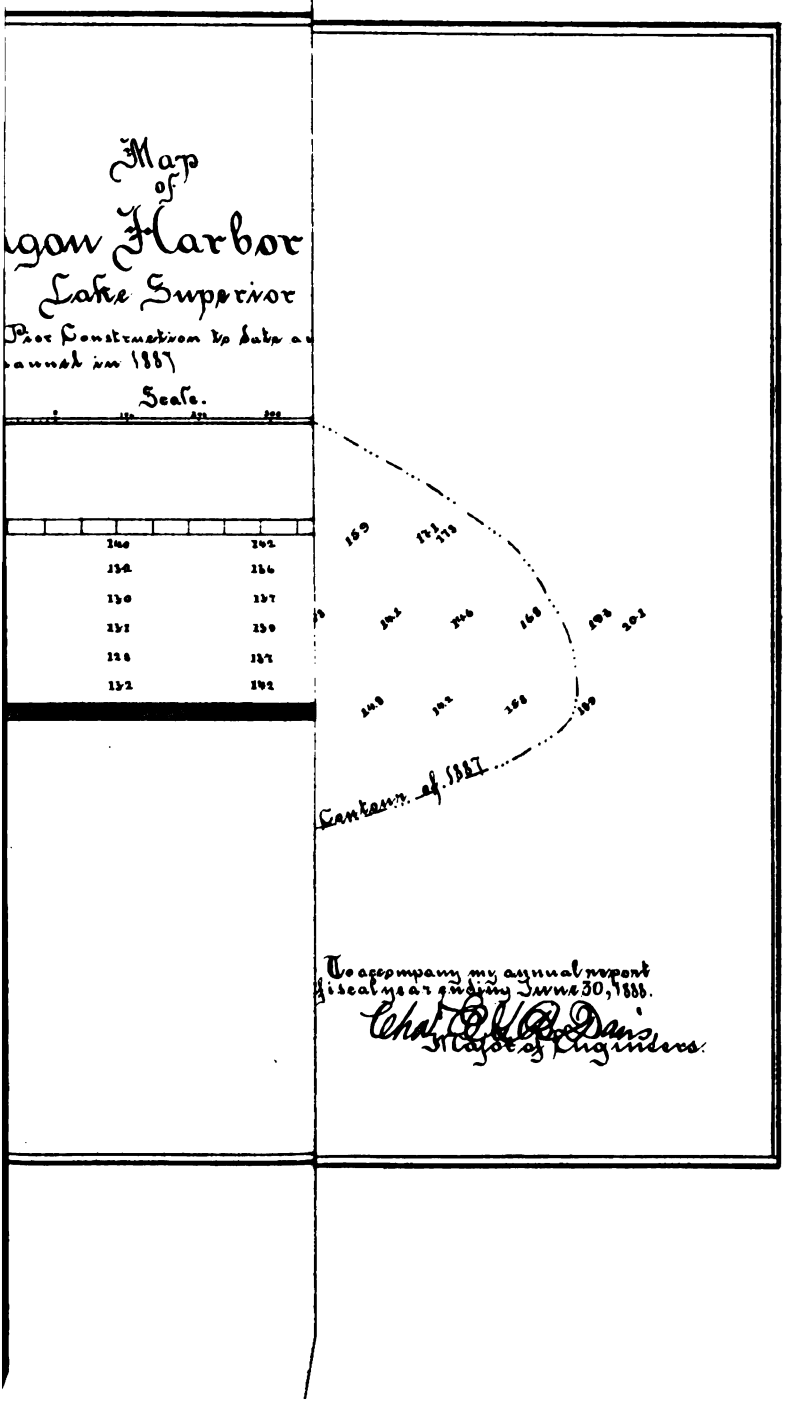
Cost per linear foot of substructure.....
Cost per linear foot of superstructure.....
Original estimates (see Report of Chief of Engin
Appropriated .....

Money staten

July 1, 1887, amount available.....
Received from sale of fuel to officer.....

July 1, 1888, amount expended during fiscal ye
outstanding July 1, 1887 .....

July 1, 1888, balance available.....
Amount appropriated by


Map
of
gon Harbor
Lake Superior
Pier Construction to Safe a
annel in 1887
Scale.
140
142
132
136
130
137
131
139
128
137
132
142
Contour of 1887
To accompany my annual report
fiscal year ending June 30, 1888.
Chas. E. L. B. Davis
Major of Engineers.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	150	99,000	150	99,000
Sail	24	12,000	24	12,000
Totals	174	111,000	174	111,000

Principal articles of export and import.

Articles.	Approximate value.
EXPORTS.	
Lumber	$270,000
Copper	40,000
Fish	14,000
General merchandise	20,000
Total	344,000
IMPORTS.	
General merchandise	160,000
Grain	12,000
Flour	9,000
Meats	6,700
Salt	500
Coal	1,500
Total	189,700

Amount of revenue collected, none.

G G 3.

IMPROVEMENT OF EAGLE HARBOR.

Object.—To secure a navigable channel from Lake Superior to Eagle Harbor and increase the available area of the harbor by breakwaters extending from each side of the channel to the shore.

Projects.—The project adopted in 1866 and modified in 1868 and 1874 was for the formation of an entrance channel 130 feet in width and 14 feet in depth through the rocky reef that obstructed the entrance of vessels drawing over 8 feet, and the construction of crib breakwaters about 1,200 feet in length.

The project was further modified in 1878 by omitting the breakwaters and substituting therefor guiding-cribs to define the channel.

Present works.—(1) The channel, 130 feet wide and 14 feet deep, was completed in 1877 and is in good condition; (2) east guiding-crib, 43 feet in length, 24 feet wide; (3) west guiding-crib, 98 feet in length, 24 feet wide. These cribs were completed in 1879 and are in fair condition.

Depth of water.—Original depth, 8½ feet; present depth, 14 feet.

Operations during the fiscal year.—None.

Remarks and recommendations.—The work accomplished meets the present demands of commerce.

No money is asked for the fiscal year ending June 30, 1890, as the

funds on hand will be sufficient to preserve the cribs and maintain the channel.

Modified estimate (see Report of Chief of Engineers, 1876, II, 328; 1877, I, 98; II, 845)	$97,000
Appropriated	97,000

Commercial statistics for the calendar year 1887 were applied for to the usual source, but no reply has been received and the statistics for the calendar year 1886 are used.

Money statement.

July 1, 1887, amount available	$2,886.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.00
July 1, 1888, balance available	2,486.33

COMMERCIAL STATISTICS.

Name of harbor, Eagle Harbor, Mich. Collection district, Superior, Mich. Nearest light-house, Eagle Harbor, Michigan.

Principal articles of export and import.

Articles.	Approximate value.
EXPORTS.	
Copper	$450,000
IMPORTS.	
Coal	45,000
Lumber	8,000
Total	53,000

Amount of revenue collected, none.

G G 4.

ESTABLISHMENT AND MAINTENANCE OF HARBOR-LINES IN PORT[illegible] LAKE, MICHIGAN.

The river and harbor act of August 5, 1886, contained the follo[illegible] clause:

SEC. 2. That in places where harbor-lines have not been established, and [illegible] deposits of debris of mines or stamp works can be made without injury to navig[illegible] within lines to be established by the Secretary of War, said officer may and is h[illegible] authorized to cause such lines to be established, and within such lines such de[illegible] may be made, under regulations to be from time to time prescribed by him.

In accordance with this authority the Secretary of War refe[illegible] the matter to the consideration of a Board of Engineer Officers, [illegible]vened August 13, 1886, and, agreeably to its recommendation, "[illegible] and regulations for the establishment and maintenance of harbor[illegible] in Portage Lake, to prevent the destruction of the through rou[illegible]

communication across Keweenaw Point," with an accompanying chart showing the location of the lines, were printed and widely distributed.

In August, 1887, a visit of inspection was made to Portage Lake, when it was found that the Quincy, Atlantic, and Pewabic stamp-mills were not complying with the intention of the law.

A report of the condition of affairs was made to the Chief of Engineers, which gave rise to a somewhat voluminous correspondence, resulting finally in instructions being issued by the Department of Justice to the United States attorney for western Michigan to apply for an injunction, restraining the mill-owners from dumping débris into Portage Lake between the harbor-lines established by the Secretary of War.

The stamp-mills on Portage Lake have been running for periods varying from twenty to thirty years, and the strict enforcement of the regulations established by the Secretary of War will entail considerable hardship on an industry which has built up the towns of Hancock and Houghton, Mich., and it is therefore probable that long and tedious litigation will be necessary before the practice of dumping débris into Portage Lake can be put a stop to.

The correspondence relating to this subject is appended herewith.

REPORT OF CAPTAIN C. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., August 16, 1887.

SIR: I have the honor to report that the following-named stamp-mills on Portage Lake are running: The Quincy, Atlantic, and Franklin.

On August 8 I visited the Quincy mill. The superintendent said they were stamping 330 tons of ore every twenty-four hours. They have a dump-scow of the ordinary pattern, which it is claimed holds 150 tons, and is dumped twice a day, morning and evening, being towed across the lake and dumped inside of the harbor-lines. The discharging-trough or "launder" runs alongside of the scow, and opposite each of its four bins discharges through a lateral trough, there being a plank set at an angle of 45 degrees on the lower side of each trough to deflect the discharge into the bins. The overflow then passes along and is discharged into the lake. Each bin has a longitudinal partition, and one-half has to be filled before the overflow can run into the second, and then this overflow runs through two outlets from each bin into the lake.

It will be seen that the scow soon fills, and the overflow runs in continuous streams over the sides of the scow and from the end of the launder, and this continues all day and all night, under the supposition that all the solid material will be caught in the scow and that the overflow will be clear water or will contain but little "slime;" but an examination of the launder when work was stopped at 5 p. m. showed that coarse material had lodged on projecting portions of the launder beyond the scow, and the appearance of the water as it is discharged would indicate that it still contained a large percentage of material in suspension. But even allowing everything worked as claimed, there would be still 30 tons per day to be accounted for, and which must be deposited in the lake.

The other two mills use no scow, and as far as I could learn—for I did not visit them—make no effort to comply with the law. The Franklin stamps about 800 tons of ore a day.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

The *CHIEF OF ENGINEERS, U. S. A.*

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1888.

SIR: Referring to previous correspondence upon the subject of dumping waste material within the harbor-lines by the operators of stamp-mills on Portage Lake, I have now to inclose, for your further information, copies of the following papers:

Letter dated December 23, 1887, from the Department of Justice to the Secretary of War, with its inclosure, and indorsement of the Chief of Engineers thereon, dated December 30, 1887.
Letter from the Secretary of War, dated January 9, 1888, to the Attorney-General.
Letter of January 11, 1888, from the Department of Justice to the Secretary of War.

By command of Brigadier-General Duane.
Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Capt. CHAS. E. L. B. DAVIS,
Corps of Engineers.

OPINION OF THE ATTORNEY-GENERAL.

DEPARTMENT OF JUSTICE,
Washington, December 23, 1887.

I have the honor to transmit herewith a copy of a report of the 15th instant from the United States attorney for western Michigan, relative to the dumping of débris into Portage Lake, which has been the subject of your previous correspondence.

After a careful investigation into the facts, the United States attorney is of the opinion that this matter involves such an obstruction of Portage Lake as will warrant an application to the courts for an injunction restraining the parties from further injury to navigation. He states, however, that the litigation will probably be lengthy and expensive, requiring the taking of voluminous testimony by engineering experts, which, in his judgment, might be avoided, for the present at least, by the presence on the ground of an officer designated to watch over the public interests, and to see that the emptying of refuse into the channel by the mill-owners is not continued.

The report is submitted for your consideration, with the assurance that the Department will be pleased to render you all the assistance in its power in order to accomplish the results in view.

Very respectfully,

A. H. GARLAND,
Attorney-General.

The SECRETARY OF WAR.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
December 30, 1887.

Respectfully returned to the Secretary of War.

Section 2 of the river and harbor act of August 5, 1886, provides:

That in places where harbor-lines have not been established, and where deposits of débris of mines or stamp works can be made without injury to navigation within lines to be established by the Secretary of War, said officer may and is hereby authorized to cause such lines to be established, and within such lines such deposits may be made under regulations to be from time to time prescribed by him.

From this it will be seen that the law permits the dumping of débris within the harbor-lines under proper regulations, and, while it does not expressly prohibit dumping outside of said lines, leaves what seems to be a fair inference that it shall not be done under any circumstances, and that it is not necessary for the Government to prove that the channel is injuriously affected by such dumping.

Taking this view, the Secretary of War approved "Regulations for the establishment and maintenance of harbor-lines in Portage Lake to prevent the destruction of the through routes of communication across Keweenaw Point," in which a penalty was provided for offenses against said law and regulations.

It was under this interpretation of the section quoted that the request was made for action by the Department of Justice.

The opinion of the United States attorney herein differs from that of the Secretary, and he suggests that action be taken under the general power conferred on the Government by the Constitution to regulate commerce, which the courts have held authorizes it to keep open and free all navigable streams, and this involves proof on the part of the United States that the dumping is injurious to navigation.

It appears to this office that it is not a question as to injury to the channel, but whether or not the law is violated by dumping outside of the harbor-lines.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

GRAND RAPIDS, MICH., *December* 15, 1887.

REPORT OF THE UNITED STATES DISTRICT ATTORNEY.

SIR: I have the honor to make the following report, in accordance with the directions forwarded to me through your Department, in reference to the complaint that the mines are dumping refuse into Portage Lake, in the State of Michigan.

First.—For the purpose of understanding what is said here, reference is made to the map of a part of Portage Lake, which is returned to the Department with this report.

Portage Lake is a long, narrow channel, reaching a large portion of the distance across Keweenaw Point, so called, which is surrounded by the waters of Lake Superior, and this lake is in use, together with the ship-canal known as the Portage Lake Canal, as a general public highway. The water opposite the mines in question is in the neighborhood of 40 to 45 feet deep in the center of the channel, and the lake at this point is narrowed up till it would seem more like a river.

The ship-canal admits vessels drawing only 13 feet of water as it is now working, and substantially all the Lake Superior traffic conducted in vessels that can enter this canal passes through Portage Lake, and it is an important public water-way in that about 90 to 100 miles are saved on the general route from and to Duluth.

This canal does not belong to the United States, but I believe some effort is being made at present to have Congress buy this canal and enlarge and deepen it. It would undoubtedly be a very valuable public improvement, and there is no doubt but that this channel, of which Portage Lake, opposite these mines, is a part, ought to be kept open and protected as a public navigable water-way to the full depth re-

ing under a warehouse that stands upon piles near the shore. Th
charging water and sand and earthy material runs through a
they call a launder, and placed at an angle of about 45 degrees, whe
water and earth passes off together, and they say that all of the ma
is heavy and sinks immediately at the point where it is put. It i
that they have room at this point to dump through the winter se
and they assert that the discharge at this point in no way inte
with the channel, or tends to fill it up. But, while I am not w
formed upon this, I have little doubt but what even this kind
dump tends somewhat to fill up the channel by floating particles.

It had long been the custom of this mine, over thirty years, to
into the lake here, and when the harbor-lines were established the
filled up and made solid ground, or rather docks, in about the rati
see upon the map, and when harbor-lines were made by the engi
they included, as navigable water, within the lines, this strip whic
ground and docks belonging to the Quincy mine.

The water opposite this Quincy dump varies from 16 to 18 feet
and 38, and at present there is ample open water-way.

You will observe on the map a bridge marked with a draw nea
Quincy dump. I was told that last summer, right opposite the Q
dump and opposite this draw, they had dumped from the Quincy
into the channel to such an extent that there was a pile upon wh
vessel struck, and that upon learning the same, the Quincy min
cured a dredge and dredged out the channel where they had filled
by dumping. It was claimed by the Quincy people, that some
their men had dumped matter from their boat within the lines a
orders, and upon its being discovered it was immediately stopped
this I have no doubt is the truth.

This mine—the Quincy—is having made this winter a boat to
away their refuse in the spring, that will contain 800 tons as a loa
with it they claim that they are already prepared to carry away t
tire discharge from their mine, and to carry it so far that by no
bility can it injure the water-way.

that it might be double that, each mine captain seeming to be desirous of representing that his débris was as small as possible.

The product of this mine for the last year, as prepared for shipment, was 7,153,500 pounds mineral, of which the stamp copper was 6,748,785 pounds, and the mass copper 404,715. They paid out in cash expenses $311,369, and for building account $276,140, smelting, transportation, and other expenses $99,425, and the business of this mine was yielding in 1886, according to their published report, $205,232.

I call attention to this that it may be seen that the interests are very large that are affected by this question, and unless necessary the Government should not interfere with this industry.

Third.—The Franklin mine and the Pewabic mine are now being operated together. They are discharging the refuse from the mills outside of the lines. You will observe by the map that the dump extends fully half way, and at one point more than that, across the harbor-lines, and this was land at the time the harbor-lines were made. It had been filled up, and the Franklin mine, as a matter of fact, judging by the eye upon the ground and as you will see also by the map, had no doubt gone beyond the center of the channel and filled it up solid. But the discharge is in a launder, in a similar manner, and now runs into the water, and, no doubt, so far as results are concerned, is about the same as said of the Quincy.

But these mines, if I am to rely upon the word of the captain, expect to dumpt upon the land and are prepared to do so, and he says they can work their mills for twenty years and dump upon the land that they have before them, and he has in course of construction the necessary machinery to bring about a dump in this shape.

The mills of these mines are made close to the lake, and this mill, like the Quincy, if compelled to stop dumping here in any manner, would be practically lost according to the information given me by its officers, and the Franklin plant is worth $250,000. The Pewabic is in some trouble, and is only being run as an adjunct to the Franklin.

They said to me in the Franklin that they run through 400 tons of rock a day, but I am, from all I could learn, of the impression that 800 tons would be nearer the mark.

I do not think, that as these mines are being operated now—the Franklin and Pewabic—that any perceptible injury is being done. As you will observe, the formation of the land by their dump is extended very much farther into the water-way than where they are now dumping. These officers argue that there is no light material floating from this débris to fill up the channel, and they all, so far as I saw mining men, told the same story.

I conversed with a man who had to do with building the bridge, and he told me that in driving his piles there were 20 feet of mud at that point, which seemed to me to be evidence that there must be a floating sediment from this débris. Yet it was the truth that when this bridge was about to be built the mines were all encouraged to bring and deposit their refuse at that point, as it was more convenient for the bridge builders to build in shallower water than was found there. It was to help in building the bridge; and this, no doubt, accounts for much of the mud found by the bridge builders.

Fourth.—The Atlantic mine is operating, and is a large establishment, and at the time of the adoption of the harbor lines had encroached upon the stream, as shown by the map. Neither this mine nor any other, so far as I could learn, have extended their dump any farther since the harbor lines were *established.*

This mine is discharging in the water westerly from their dum a good distance from the harbor lines. It was said 200 feet, b hardly that.

This mill breaks about 1,000 tons of rock a day. Its plant is $500,000, and the necessity to the existence of this plant is that a ing-ground shall be at a point where they are now dumping—not necessarily in the water—but they are prepared to dump upon th and say they have the necessary land to last them an indefinite t

The income and value from the works of this mine are, no similar ratably, measuring by the ton, to the others.

Upon the question as to whether, upon this apparent state of the channel is being closed, I do not pretend to be competent to I interviewed a large number of people whose interest it is to hav channel properly maintained, and all there seemed to think tha is now being operated the channel is safe. The demand of th munity seemed to be that it be not further encroached upon, and mines had had their attention challenged to this question befor it was a common subject of talk in the towns, so that I believ opinion was substantially the result of the discussion. Of cou need not be thought that I interviewed any person living ther was not interested more or less. Yet some of the gentlemen I sa interested in mines—the Calumet and Hecla and other mines that into Torch Lake—and are not subject to any question of this kin they apparently did not fear for the channel if it is not further i by general dumping. It had for many years been the custom out into the lake and dump where it was most convenient. Since parties have used these scows.

It seemed to be the almost universal opinion that these estab wharf-lines, between the cities of Houghton and Hancock, of 9 1,000 feet was an unnecessary width. I talked with vessel men, others, and believe that if a channel is insisted upon at 500 feet points it would accommodate the public travel. As you will s examination of the map opposite these old dumps the channel that width, and it was complained to me by owners of the banks site the Franklin dump that the Government had established a line on their side clear up to the water's edge; and it is a hill, to injury, they claimed, and insisted that this ground made by the I lin dump ought to be removed and the wharf-line upon the op side more equitably located.

It will be seen by an examination of the map, which disclos location of the mines, that there are narrow places in the chann posite the mines, while at other points there would be no diffic maintaining 1,000 feet as the wharf-lines, and these wide places also afford convenient turning-room for large vessels.

I only call attention to these things as a part of the situatio was represented to me, and do not pretend to knowledge as to should be these wharf-lines.

Sixth.—The course of proceeding, if any should be taken with ence to this matter, would be by proceedings in chancery. The have held that the power conferred on the General Government Constitution to regulate commerce authorizes it to keep open an all navigable streams.

This matter was discussed in the 13 How., 519; that the cou *equity* have jurisdiction over these matters by way of injunction a *obstructions* to navigation is elementary. The subject was cons *in the* Supreme Court, 2 Black, 485; also in Gibbons *vs.* Og *Wheat.*, 1; also 22 How., 227.

The whole law of this question was gone into at great length in California, and an exhaustive opinion by Circuit Judge Sawyer filed the 7th of January, 1884; and it is enough to say, for the purpose of this report, that the law furnishes by injunction ample means to control, so far as injunctions will do so, the obstruction of this and other public water-ways.

And this may be sufficient answer to the request of the Secretary of War for advice as to "what action can be taken by this Department on the part of the United States to prevent the dumping of the débris from these stamp mills into the channel of Portage Lake, and outside the harbor lines."

I ought to say something, perhaps, with reference to what should be done, if procedings are thought necessary.

It would be necessary that the Corps of Engineers should go on and make full measurements, to ascertain, by scientific information, some way to establish that the course pursued by these mines does obstruct or aid in obstructing the water-way. This would be disputed. It would be necessary to have some proper person to procure such testimony as might be found in the locality, or elsewhere, tending to show whether this channel has been filled by this kind of proceedings, and to what extent. We would be met at every point with a stubborn contest.

The minutes of what occurred in the California case show that the suit was begun in July, 1882, and was decided in January, 1884. The testimony taken amounted to 40,000 folios. The testimony of engineers seems to be almost equally strong upon both sides, and these minutes suggest the kind of difficulties we should meet with here, and litigation of this kind, if begun and carried to an end, would be very expensive.

Seventh.—I am instructed by the letter to the United States attorney at Milwaukee, of September 1, 1887, file No. 5936, to examine into the facts and report to the Department the result of my inquiry, "together with such recommendations, with reference to the institution of legal proceedings, as in my judgment would be best for the public interests concerned."

I am not sure that I am fully competent to make any recommendation upon the subject, and thus report you fully, as I have, the situation. So far as I have been enabled to inform myself it does not seem to me that it is unnecessary to file bills against these mine owners, or to institute any other legal proceedings.

You will observe attached to the map a provision for fining persons obstructing the channel to the amount of $1,000 fine, and it might have been thought by a casual notice of this that this would be the course of proceeding.

It seems this provision for a fine is an order from the Secretary of War, promulgated at the suggestion of the engineer in charge. I am unable to find any power or authority in the Secretary for the enacting of a law by which a citizen not subject to the commanding officer in the War Department may be fined $1,000, or any other sum; and it seems to me, without giving it other than the casual attention that I have, that this provision can not be enforced. I do not suppose that any person is liable to fine under that provision.

In order to restrain by injunction, it would be necessary, of course, to establish the existence of the facts with considerable certainty. This suggests itself to me, in that it is a fact that every mine owner there readily promises that nothing shall be done to injure the channel; *i. e.*, that if some person there had authority to watch and deal with persons found discharging matter *into the water*, this person acting in the name

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LETTER OF THE SECRETAR

Washingt

SIR: I have the honor to acknowledge th
the 23d ultimo, inclosing a copy of a repor
attorney for Western Michigan relative to the
into Portage Lake, who expresses the opinion
such an obstruction to Portage Lake as will w
the courts for an injunction restraining the pe
to navigation, and states that litigation will
expensive, and in his judgment might be avoid
officer designated to see that the emptying of
the mill-owners is not continued.

In reply I beg to request that you will caus
be taken to obtain an injunction restraining
from dumping débris in Portage Lake betwee
lished by the Secretary of War in accordanc
section 2 of the river and harbor act of August

A copy of the regulations establishing these

Very respectfully, your obedient servan

The honorable the ATTORNEY-GENERAL.

LETTER OF THE ATTORNEY-

G G 5.

IMPROVEMENT OF MARQUETTE HARBOR, MICHIGAN.

Object.—To afford protection to the water-front of the city from easterly and northerly gales.

Project.—The project adopted in 1866 was the construction of a crib breakwater 2,000 feet long. It was completed for a length of 2,010 feet in 1875.

Present works.—A breakwater built 1867–1875, extending from the shore due south for a distance of 2,010 feet. The first or inshore section of 100 feet is formed of stone of large dimensions placed symmetrically. The second section consists of 160 feet of cribs 20 feet wide, the third section of 150 feet of cribs 25 feet wide, and the fourth section of 1,600 feet of cribs 30 feet wide. The first, second, and third sections are in good condition, the two latter having been rebuilt above the water-line in 1886.

The superstructure on the fourth section is from thirteen to nineteen years old, and in more or less bad condition. Three hundred feet built in 1869 should be rebuilt at an early day.

Depth of water.—The natural depth of water at the outer end of the breakwater is 32 feet.

Operations during the fiscal year.—The breakwater was injured by heavy storms in October, 1887, the damage extending at intervals for a distance of about 900 feet, the upper two or three courses of timber on the east side of the breakwater being torn away and some of the planking lost.

The necessary repairs were made by hired labor and purchase of materials in open market. Work commenced November 16, and the repairs were completed December 3 at a cost of $738.86. Water-level observations were made and recorded daily during the year.

Remarks and recommendations.—The estimated annual cost of maintaining the present breakwater is $4,200. Its exposed position renders it necessary to make prompt repairs if damages occur, to prevent greatly increased injury; therefore an annual appropriation of $4,200 is urgently recommended for this purpose.

This harbor is of great importance, its commerce being very extensive and constantly increasing, and it is also valuable as a harbor of refuge. The facilities it affords are inadequate, and as soon as proper harbor lines are established it should be enlarged by extending the breakwater on its present course for a distance of 1,200 feet. This would cost about $200,000, would increase the available anchorage area over 100 per cent., and afford ample protection for the present commerce.

The serious encroachment upon the available anchorage area protected by the breakwater made by dock-owners and others, and complained of in previous annual reports, seems to be in a fair way of adjustment, and it is believed that the city authorities of Marquette will establish satisfactory harbor lines.

Original estimate (see Report of Chief of Engineers, 1866, III, 8; IV, 81)	$385,129.58
Appropriated	329,230.00

Money statement.

July 1, 1887, amount available	$10,323.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,322.96
July 1, 1888, balance available	9,000.86
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	34,000.86

Amount (estimated) required for completion of proposed project.....$175
Amount that can be profitably expended in fiscal year ending June 30, 1890 100
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by C. H. Call, collector of customs.]

Name of harbor, Marquette, Mich.; collection district, Superior, Mich.; light-house, Marquette, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Depart
	Number.	Tonnage.	Number.
Steam	280	250,789	280
Sail	415	269,783	415
Total	695	520,572	695

Principal articles of export and import.

Articles.	Ap
EXPORTS.	
Iron ore	
Pig-iron	
Lumber, timber, laths, and shingles	
Machinery	
Brownstone, powder, etc	
Miscellaneous	
Total	
IMPORTS.	
Coal	
Flour and feed	
Machinery	
Miscellaneous	
Oil and provisions	
Brick, iron rails	
Total	

Amount of revenue collected .....

G G 6.

HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

Object.—To render the bay of Grand Marais available as a ha refuge by the formation of a channel 18 feet in depth, the natura being but 6 feet.

The necessity for a harbor of refuge on the American shore o Superior, at some point between Whitefish Bay and Grand Is distance of 85 miles, was felt by navigators long before the con of the lake had assumed the importance it now possesses.

Grand Marais, from its locality, about midway between these points, and from its natural topographical features, seemed to be the most desirable place for the construction of a work of the character needed.

Project.—The present project, adopted in 1881, provides for an artificial entrance, to be obtained by the construction of two parallel crib-piers 500 feet apart, with a dredged channel between them and through the sand-spit north of the harbor, having a least width of 300 feet and a depth of from 18 to 20 feet.

Present work.—(1) East pier, 850 feet in length, 100 feet of which at the inshore end is a pile-dike 10 feet wide, the next 700 feet being of cribs 20 feet wide, and the last 50 feet of cribs 24 feet wide. The superstructure, 6 feet in height, is completed upon the dike and upon 200 feet of the crib-pier adjacent thereto; the remainder, 550 feet, is built to the water-surface only. (2) West pier, 1,250 feet in length, composed of 100 feet of pile-dike 10 feet wide, 700 feet of cribs 20 feet wide, and 450 feet of cribs 24 feet wide. The superstructure, 6 feet in height, is completed upon the dike and upon 300 feet of the cribs; the remainder, 850 feet, is built to the water-surface only.

The dikes were built in 1885, the crib-piers 1883–'88, and they are in good condition.

Depth of water.—Originally 6 feet.

A channel 75 feet wide and 10 feet deep was opened between the piers in 1883 by dredging 32,104 cubic yards of material. Before the close of the season severe storms caused a breach at the inner end of the west pier, which resulted in obliterating the channel, and it has not been reopened, as it was evident that it could not be maintained until the piers were extended.

Operations during the fiscal year.—Under the contract of Mr. Castle Sutherland, of East Saginaw, Mich., dated October 25, 1886, for 450 feet of pier extension, work had just begun at the beginning of the fiscal year.

One crib was built and three others commenced, but none of them were sunk in place, when Mr. Sutherland abandoned the work and his contract was annulled.

A contract, dated July 25, 1887, was then entered into with Messrs. Truman & Cooper, of Manitowoc, Wis., the next lowest bidders, for 400 feet of pier extension. Under this contract the west pier was extended 200 feet by sinking four cribs, each 24 feet wide, during the month of June, 1888. To complete the contract four more cribs are to be sunk by July 31, 1888.

Remarks and recommendations.—A sketch of the harbor is transmitted herewith, showing the work constructed to date, and the effect of wave action upon the lake bottom, which it is thought may be of general interest.

That some benefit may soon be derived from the large expenditures at this harbor it is desirable to open the artificial channel at the earliest possible date. The west is the weather pier, and upon the completion of the present contract it will terminate at the 19-foot contour, the outer 1,050 feet extending to the water-surface only.

It may, therefore, properly be a question whether, in the event of a large appropriation being available, it may not be well to expend a part of it in dredging a channel 150 feet wide and 14 to 15 feet deep.

The appropriation asked is to be applied to continuing pier construction, and perhaps dredging. The importance of completing this work at an early day can hardly be overestimated, and the great increase in

July 1, 1888, amount expended during fiscal year, e
liabilities outstanding July 1, 1887 .....
July 1, 1888, outstanding liabilities .....
July 1, 1888, amount covered by existing contracts

July 1, 1888, balance available .....
Amount appropriated by act of August 11, 1888 .....

Amount available for fiscal year ending June 30, 188

Amount (estimated) required for completion of exi
Amount that can be profitably expended in fiscal year
Submitted in compliance with requirements of s
harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CAL

[Furnished by W. Bell.]

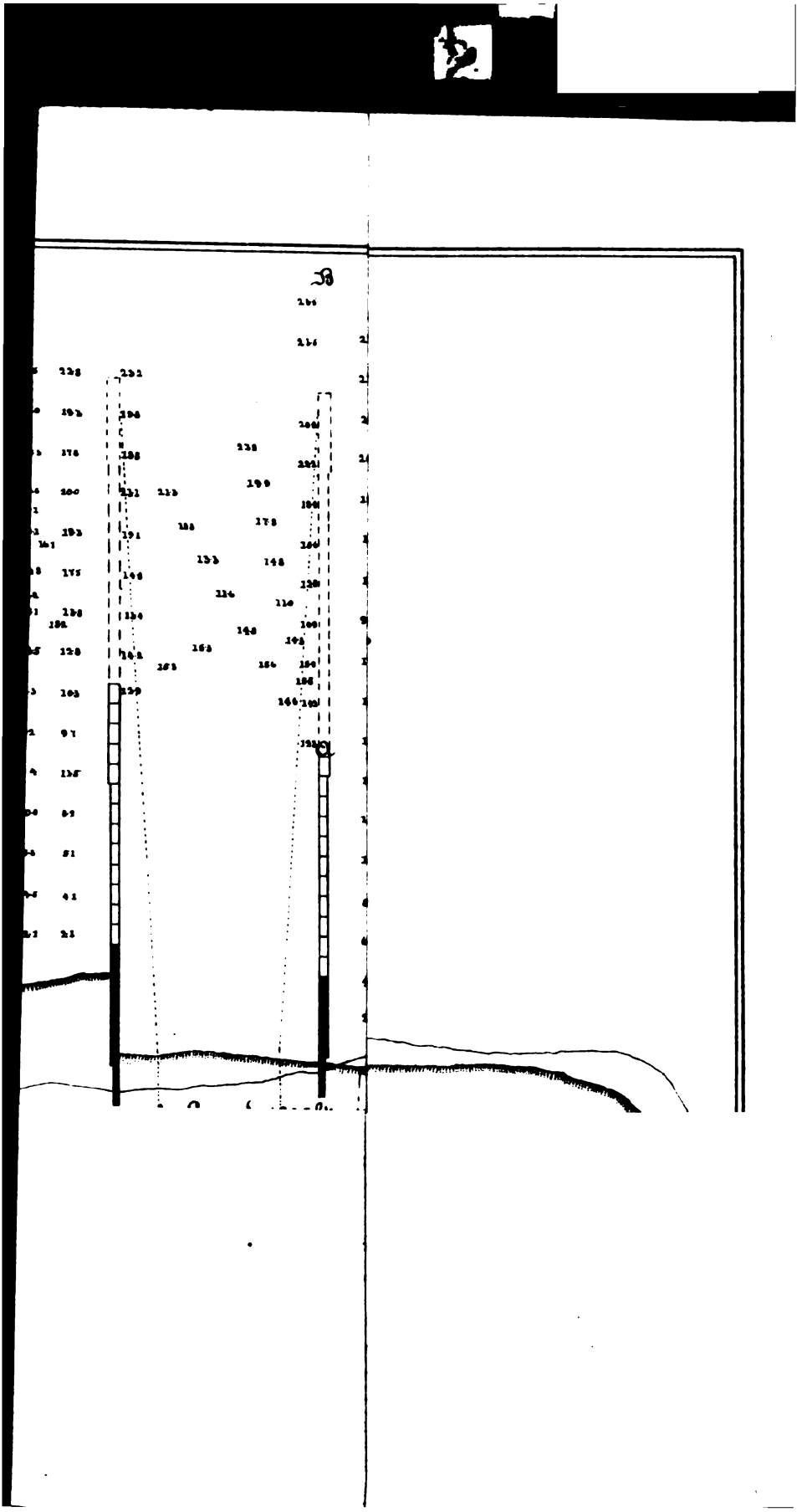
Name of harbor, Grand Marais, Mich. Collection d
light-house, Big Sable, Mich.

Arrivals and departures of v

Description.	N
Steam	
Sail	
Totals	

Principal articles of export an

Articles.



the commerce of Lake Superior would seem to justify large annu
propriations until the harbor is completed.

Original estimate (see Report of Chief of Engineers, 1881, p. 2053) ..... $
Appropriated .....

Money statement.

July 1, 1887, amount available		$28
Received from sale of fuel to officer		
		28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,152.59	
July 1, 1888, outstanding liabilities	859.77	
July 1, 1888, amount covered by existing contracts (estimated)	16,400.00	
		26
July 1, 1888, balance available		1
Amount appropriated by act of August 11, 1888		50
Amount available for fiscal year ending June 30, 1889		51
Amount (estimated) required for completion of existing project		268
Amount that can be profitably expended in fiscal year ending June 30, 1890. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		200

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by W. Bell.]

Name of harbor, Grand Marais, Mich. Collection district, Superior, Mich. light-house, Big Sable, Mich.

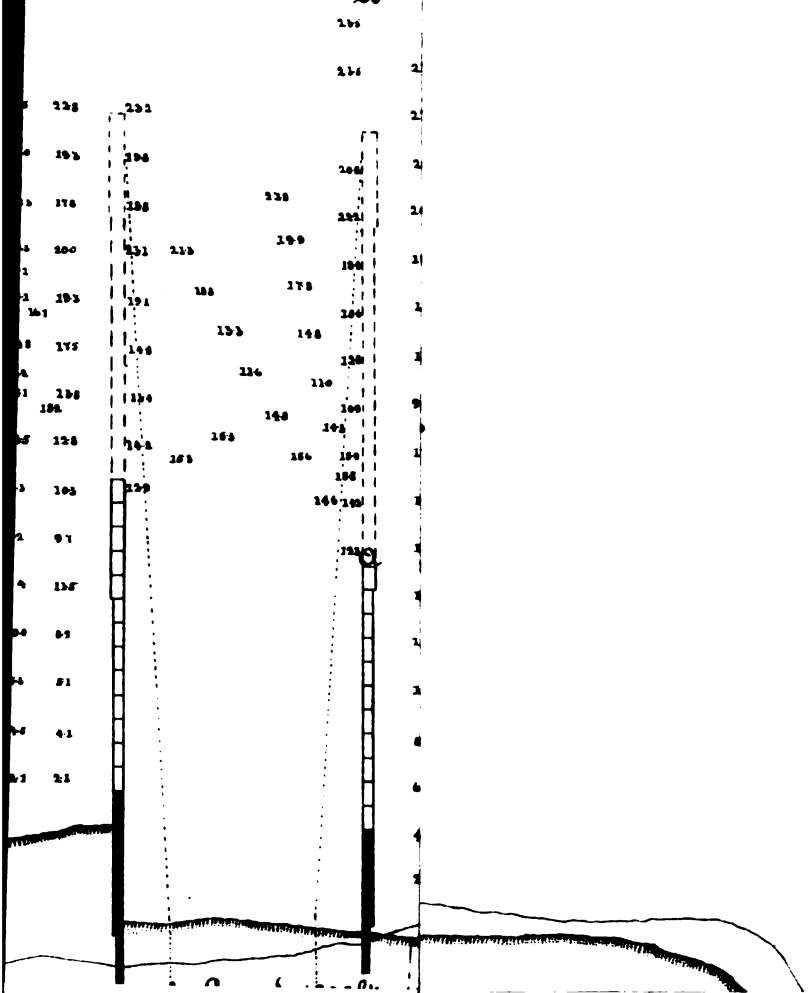
Arrivals and departures of vessels.

Description.	Arrivals.		Depart
	Number.	Tonnage.	Number.
Steam	19	3,025	19
Sail	19	2,800	17
Totals	38	5,825	36

Principal articles of export and import.

Articles.	Ag
EXPORTS.	
Wood	
Fish	
Farm produce	
Total	
IMPORTS.	
Timber	
Lumber	
Iron (manufactured)	
Hay and grain	
General merchandise	
Stone	
Total	

Amount of revenue collected, none.



G G 7.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into Manistique River, which is the harbor of Manistique.

Project.—The original project, adopted in 1880, provided for the excavation of about 20,000 cubic yards of material to complete a channel 150 feet wide and 12 feet deep between piers constructed by local enterprise at the mouth of Manistique River.

Present works.—Not any.

Depth of water.—Originally 7 feet; increased to 10 feet by private enterprise before any appropriation had been made by the Government. Present depth not known.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—An appropriation of $5,000 was made for this harbor in 1880, and of $1,000 in 1881.

The only work done under these appropriations was the removal of 11,780 cubic yards of material in 1880, under a contract with the Chicago Lumbering Company.

In October, 1880, a survey of the harbor showed that the direction of the piers lay across the natural channel. At this time the company, which had built the piers and had also secured the contract for dredging, found it necessary to renew about 330 feet of the west pier, which had been washed away.

The superintendent of the company was notified by the officer in charge, Maj. H. M. Robert, that the pier lines would have to be rectified to accord with the natural channel. The company declined to comply with this demand, and their contract, which had been extended from December, 1880, to June 1, 1881, was suspended. There have been no operations at this harbor since, and no money is asked for its improvement.

Original estimate (see Report of Chief of Engineers, 1880, page 1931)	$6,000
Appropriated	6,000

Money statement.

July 1, 1887, amount available	$3,501.79
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.00
July 1, 1888, balance available	3,101.79

G G 8.

IMPROVEMENT OF CEDAR RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Green Bay into Cedar River.

Project.—The original project adopted in 1883 provided for the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot contour in Green Bay, and dredging a channel between them 14 feet deep. Also removing an outer shoal by dredging to a depth of 15 feet.

A modification of this project approved in 1884 provided for cont ing the piers in a direct line with the part already built instead c an angle, as originally proposed.

Present works.—Pile-piers lined with sheet piling: (1) East Pier feet in length, 16 feet wide; (2) West Pier 301 feet in length, 16 wide. All were built in 1883–'85, and are in good condition.

Depth of water.—Originally 8 to 10 feet, obstructed by a 3-foot b front of the mouth.

Soundings made in October, 1885, showed a channel about 50 fe width, 13 feet deep, and 100 feet in width, 11 feet deep.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—The commerce of Cedar River i tirely local and incidental to a single saw-mill. A harbor of refuge not seem to be needed at this point, and if it were, the conditions not favorable for its construction. No appropriation for continuing improvement has been recommended since 1885.

Original estimate (see Report of Chief of Engineers, 1882, page 2121)....	$13
Appropriated	3

Money statement.

July 1, 1887, amount available	$2,6
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3
July 1, 1888, balance available	2,3

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	108,0

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by Spalding Lumber Company.]

Name of harbor, Cedar River, Mich. Collection district, Superior, Mich. N light-house, Chambers Island, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departur	
	Number.	Tonnage.	Number.	To
Steam.....	195	45,000	195	
Sail.....	175	59,000	175	
Total.....	370	104,000	370	

Principal articles of export and import.

Articles.	Approximate value.
EXPORTS.	
umber, lath, pickets, and shingles	$650,000
osts, poles, and ties	125,000
abs	6,000
ish	9,000
Total	790,000
IMPORTS.	
roceries, etc	30,000
rovisions	16,000
rain, hay, and feed	25,000
on, steel, hardware, etc	17,500
rick, coal, and lime	1,500
eneral merchandise, etc	25,000
orses, cattle, and oxen	13,000
Total	128,000

Amount of revenue collected, none.

G G 9.

IMPROVEMENT OF MENOMONEE HARBOR, MICHIGAN AND WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Meomonee River.

Project.—The original project adopted in 1871 provided for the construction of two parallel piers 400 feet apart, extending from the mouth f the river to the 15-foot contour in Green Bay, and dredging a chanel between them 14 feet deep. In 1874 it was decided to extend the iers to the 16-foot contour.

Present works.—(1) North pier, 1,854 feet in length, consisting of 585 eet of slab-pier 20 feet wide; 609 feet of pile-pier, 481 feet of the same aving a width of 14 feet and 128 feet a width of 18 feet; 660 feet of ribs, 610 feet with a width of 20 feet and 50 feet with a width of 24 eet. (2) South pier, 2,710 feet in length, consisting of 1,900 feet of pile-ier, 1,804 feet having a width of 14 feet and 96 feet a width of 18 eet; and 810 feet of cribs 20 feet wide.

The pile-piers were built 1871–1874, and the cribs 1876–1884.

The cribs are in good condition. It is probable that some repairs will e needed to the pile-piers at an early date.

Depth of water.—Originally 4 feet. In 1886 at the outer end of the orth pier, 16 feet; south pier, 11 feet. In 1886 a channel 270 feet in idth and 14 feet deep was dredged between the piers and through an uter bar that projected from the south pier-head.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—The navigation of this harbor preents some peculiar and exceptional features, viz: Vessels entering for argoes come light, and no heavily laden craft seek it for shelter; the eparting lumber-laden vessels, with a draught of 13 or 14 feet, wait or smooth water, and consequently the usual allowance of 4 feet play n depth is not necessary at this harbor.

The extension of the south pier is not considered necessary, for if the bar should reform it could be removed by dredging at small expense.

The Menomonee River Lumber Company still continue their unauthorized and improper use of the south pier by piling their lumber thereon, while they moor heavy barges and scows to the north pier.

It is proposed to apply available funds to the maintenance of the channel and piers.

Original estimate (see Report of Chief of Engineers, 1874, Part I, page 139)	$212,000
Appropriated	203,000

Money statement.

July 1, 1887, amount available	$3,100.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	730.21
July 1, 1888, balance available	2,370.30
Amount appropriated by act of August 11, 1888	9,000.00
Amount available for fiscal year ending June 30, 1889	11,370.3[illegible]

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887

[Furnished by C. H. Call, collector.]

Name of harbor, Menomonee, Wis. Collection district, Superior, Mich. Near[illegible]t light-house, Menomonee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	203	21,286	203	21,[illegible]
Sail	387	78,798	387	78,[illegible]
Total	590	100,084	590	100,[illegible]

Principal articles of export and import.

Articles.	Approximate value.
EXPORTS.	
Lumber	$4,26[illegible]
Lath	57[illegible]
Shingles	1,67[illegible]
Pickets	5,440
Total	6,605,440
IMPORTS.	
Provisions and general merchandise	1,158,[illegible]

Amount of revenue collected, none.

G G 10.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay up the Oconto River to the city of Oconto.

Project.—The original project adopted in 1882 provided for the formation of a channel 100 feet wide and 8 feet deep, by extending the slabpier built by the city to the 10-foot contour in Green Bay, and dredging between them and up the river to Section Street Bridge, a distance of about 2 miles; the piers to be parallel to each other and 150 feet apart.

Present works.—(1) North pier, 1,603 feet long, 20 feet wide. For 1,100 feet the piles are 5 feet apart; for the remaining 503 feet the piles are feet apart on the channel side and 2 feet apart on the outer side, the latter being provided with walling timbers, cross-ties, and tie-rods. The filling is composed of slabs and edgings ballasted with sand. (2) South pier, 2,151 feet long, 20 feet wide. For 1,850 feet the piles are 5 feet apart; the remaining 351 feet is close piling. The filling is composed of slabs and edgings ballasted with sand, except the outer 301 feet, which is covered with 2 feet thickness of stone. (3) The outer side of the south pier, beginning 300 feet from the outer end, for a distance of 1,000 feet, is protected from ice-pressure by a line of close piling. (4) Additional stability is given to 1,200 feet of the south pier by a line of piles on the channel side 3 feet apart, provided with walling timbers, cross-ties, and iron tie-rods at intervals of 9 feet.

These piers were built 1882–1885, and are in fair condition, except sections 8 to 13 of the north pier, a distance of 300 feet; a severe freshet that occurred in May, 1888, having caused a settlement of the filling. About one hundred cords of slabs or stone are required to bring the filling up to a proper height.

Depth of water.—Originally 2 feet, increased to 3½ feet by local enterprise. Soundings made in July, 1887, show a channel between the piers about 30 feet wide and 8 feet deep. An available channel 6 feet deep extends up the river to Spies's mill, a distance of about one mile.

Operations during the fiscal year.—By hired labor and open purchase the construction of 1,200 feet of re-enforcement piling on the channel side of the south pier was in progress at the beginning of the fiscal year, and was completed in July, 1887.

Remarks and recommendations.—The history of this work of improvement is somewhat peculiar.

A survey of the mouth of the Oconto River was ordered by the act of July 11, 1870, and was made in the same year under the direction of Maj. D. C. Houston, Corps of Engineers, who reported that—

> General commerce and navigation will not be benefited by a harbor at this point. The amount required for the active and permanent completion is $500,000. (See Report of Chief of Engineers for 1871.)

The act of March 3, 1879, directed a re-examination or survey, which was also made under Major Houston's direction, and in October, 1879, that officer reported a reduced estimate, amounting to $382,027.18. (See Report of Chief of Engineers for 1880.) Both of these estimates were based on securing a 12-foot channel.

In January, 1881, the Secretary of War was informed that the citizens of Oconto had undertaken the work of improvement on a much more

economical plan than that recommended by the Government engineer, and a request was made for a further examination, with the hope that a small appropriation might be made in *aid* of the work. Major Houston made an examination, and while not indorsing the method of construction adopted by the citizens, reported that an appropriation of $5,000 or $10,000 "would be of great assistance" to the people in carrying on the work of improvement.

The character of the citizens' plan and estimate may be judged from the fact that they proposed to build 1,800 feet of pier for $1,500, or 83⅓ cents per linear foot.

The act of March 3, 1881, appropriated $10,000 for improving Oconto Harbor, it is believed, on the strength of the above-quoted remark of Major Houston.

Maj. H. M. Robert, Corps of Engineers, having succeeded to the charge of the work, submitted a project in 1881 to obtain an 8-foot channel, at an estimated cost of $125,000. This was modified in 1883, the revised estimate involving a total cost of $150,000, which is the project at present being carried out.

The first appropriation for this harbor was made in 1881, and work was begun in the ensuing year.

The channel is often used for booming and mooring logs and lumber scows, and the piers, built in the cheapest practicable manner, are constantly receiving injuries from such use, the piles being frequently broken and the slab filling washing out. That part of the piers built by the citizens was so poorly constructed, that unless rebuilt or extensively repaired it will soon afford no protection, and render the outside work unavailable.

The south pier is built to the full length contemplated by the approved project.

To complete the north pier to the 10-foot contour, as originally designed, would require an extension of 875 feet, at a cost of about $10,000. As the south pier is the weather pier, and as the north pier is protected by the south pier and by Peshtigo Point, it would seem to be unnecessary to extend the north pier farther.

It is recommended that, if Congress should continue to make appropriations for this improvement, the expenditure of the money be made contingent on the city of Oconto keeping in repair the part built by private enterprise.

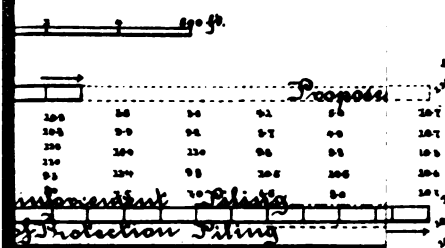
Materials and labor used in building 1,200 linear feet of re-enforcement piling to the south pier.

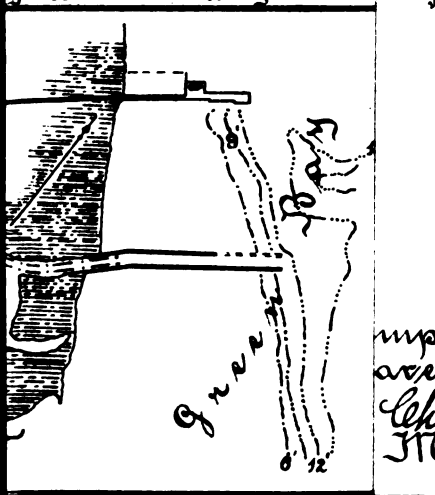
18,091 pounds screw-bolts and tie-rods, at 3.1 cents	$560.8
21,196 feet, B. M., pine timber, at $15.43 per thousand	327.0
10,416 linear feet pine piles, at 9⅜ cents	976.5
108.22 cords stone, at $4.24	458.8
Repairs and purchase of tools, etc	230.7
Towing, fuel, and hire of scow for pile-driver	168.0
Labor	1,020.4
Total	3,742.3
Estimated cost (see Report of Chief of Engineers, 1883, page 1646)	150,000
Appropriated	48,000

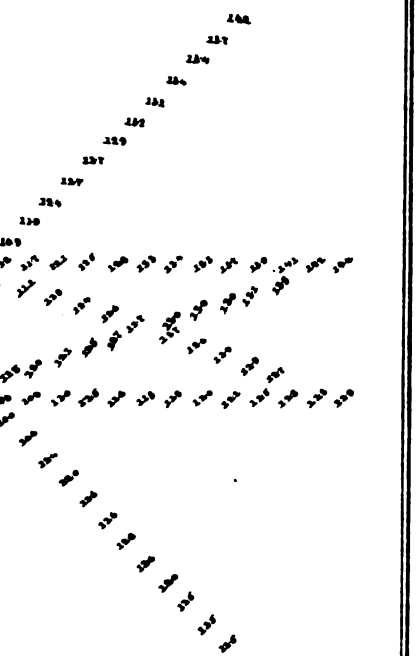
Commercial statistics for the calendar year 1887 were applied for to the usual source, but no reply has been received, and the statistics for the calendar year 1886 are used.

bor, Wisc.

ction to date and
el in July, 1887.







mpany my annual report
ending June 30, 1888.

Chas. E. L. B. Davis,
Major of Engineers.

Money statement.

87, amount available	$4,104.14
88, amount expended during fiscal year, exclusive of liabilities ding July 1, 1887	3,904.50
88, balance available	199.64
ppropriated by act of August 11, 1888	20,000.00
vailable for fiscal year ending June 30, 1889	20,199.64
(estimated) required for completion of existing project	82,000.00
that can be profitably expended in the fiscal year ending June 90	2,000.00

ted in compliance with requirements of sections 2 of river and r acts of 1866 and 1867.

COMMERCIAL STATISTICS.

f harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest light- erwood Point, Wis.

Arrivals and departures of vessels.

	Number.	Tonnage.
	172	86,000
	169	83,000
	341	169,000

Principal articles of import and export.

Imports.	Value.*	Exports.	Value.*
and stone	$65,000	Lumber, lath, and shingles	$720,000
gs	360,000	Cedar posts and ties	140,000
and ties	80,000	Slab wood	18,000
rchandise	280,000	Farm products	68,000
ay	18,000	Telegraph and hoop poles	18,000
od	11,000	Boxes, crates, sash, doors, etc	125,000
	734,000	Total	1,069,000

*Approximate.

G G 11.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

—To secure a navigable channel from Green Bay into the Pen- River.

ct.—The original project, adopted in 1883, provides for continu- lab-pier, which had been built by private enterprise, until it reach the 10-foot contour in Green Bay, and dredging a channel f it to a depth of 10 feet, and width of 100 feet, connecting the ter in the river with the deep water in the bay.

Remarks and recommendations.—There
and consequently no necessity for askin
tinuing the improvement.

Estimated cost (see Report of Chief of Enginee
Appropriated .....

Money statem

July 1, 1887, amount available .....
July 1, 1888, amount expended during fiscal yea
outstanding July 1, 1887.....

July 1, 1888, balance available .....

Amount (estimated) required for completion of
Submitted in compliance with requirements of
and harbor acts of 1866 and 1867.

G G 12.

IMPROVEMENT OF GREEN BAY E

Object.—To secure a more direct and
Bay into the Fox River, which is the harl

Project.—The original project, adopted
ing a channel 200 feet wide and 12 feet
Fox River, through Grassy Island, to the
a distance of about 8,800 feet, and revetti
at Grassy Island. This project was comp

A supplementary project, adopted in 1
ing the channel and increasing its depth

In 1874 it was decided to increase the d
the length to about 10,000 feet.

Present works.—Revetments at Grassy
620 feet long and 14

dth was but 175 feet, the remaining 25 feet on the east side having a pth of from 10 feet to 12 feet.

Operations during the fiscal year.—By hired labor and open purchase e superstructure, 5 feet in height, was rebuilt upon the west revetent at Grassy Island for its entire length of 620 feet.

Remarks and recommendations.—The maintenance of a good channel important for the navigation of the Fox River, and in the event of oney being appropriated for the continuance of this work it is prosed to expend it, or as much as may be necessary, in dredging the annel to the dimensions required by the existing project. Small anual expenditures will be necessary to maintain this long, narrow annel.

terials and labor used in repairing 620 linear feet of the west revetment at Grassy Island.

071 pounds screw and drift bolts, at 2.74 cents per pound	$440.34
' cords edgings, at $1.50	160.50
634 feet, B. M., pine timber, at $15.43 M	1,491.06
04 linear feet pine piles, at 10 cents	170.40
3.58 cords stone, at $3.74	686.59
rchase and repair of tools, etc	97.53
ansporting men, etc., towing and scow-hire	260.70
bor	1,405.49
Total	4,712.61

timated cost of present project (see report of Chief of Engineers, 1881, page 2069)	$135,000
propriated	105,000

Money statement.

ly 1, 1887, amount available	$5,421.14
ceived from sale of fuel, to officer	16.50
	5,437.64
ly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,229.61
ly 1, 1888, balance available	208.03
ount appropriated by act of August 11, 1888	10,000.00
ount available for fiscal year ending June 30, 1889	10,208.03
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by Robert Barclay, deputy collector of customs.]

Name of harbor, Green Bay, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
amers	333	35,728	337	36,002
pellers	125	60,686	125	60,392
ooners	164	36,009	168	36,331
Total	622	132,423	630	132,725

Principal articles of export and import.

Articles.	Value.
EXPORTS.	
Grain	$167,000
Flour	960,000
Lumber	75,913
Brick	10,000
General merchandise	100,000
Total	1,312,913
IMPORTS.	
Coal	383,550
Iron	34,000
Lumber	10,000
General merchandise	300,000
Total	727,550

G G 13.

HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY CANAL, WISCONSIN.

Object.—The formation of an outer basin covering the Lake Michigan entrance to the Sturgeon Bay and Lake Michigan Ship-Canal, to serve as a small harbor of refuge, and to enable vessels seeking a more commodious harbor than it affords to enter the canal in safety, passing through it into Sturgeon Bay, which possesses all the requirements of a perfect harbor of refuge for all the lake commerce.

Project.—The original project submitted in 1871 and adopted in 1873 provided for the construction of converging piers 850 feet apart at the base and 250 feet apart at the outer end, each about 1,200 feet in length, extending to the 18-foot contour in Lake Michigan and dredging the inclosed area.

Supplementary projects adopted in 1879 and 1880 did not change the object of the original project, but provided for sheet-piling the pile-piers, extending each pier 150 feet by detached works, so as to increase the width of entrance from 235 feet to 335 feet, and dredging to obtain a least 16 feet in depth over so much of the area of the basin as would b useful to vessels entering the harbor.

Present works.	Width.	North Pier, length.	South Pier, length.
	Feet.	*Feet.*	*Feet.*
Slab-pier:			
Piles 4 feet apart	14	100	100
Close piling	14	150	150
Pile-pier, close piling	14	512	512
Do	18	32	32
Crib-pier	20	200	200
Do	24	200	200
Length of each main pier		1,194	1,194
Crib-piers	24	100	100
Do	30	50	50
Length of each detached pier		150	150
Total length of each pier		1,344	1,344

Guide piling to connect main and detached piers, total	feet	333
North slab and pile-pier, sheet piled	do	683
South slab and pile-pier, sheet piled	do	700
Number of cubic yards of material dredged		132,344

The slab and pile piers were built in 1873–'74; they are in fair condition, but their age renders probable repairs necessary at an early day.

The crib-piers and guide piling were built 1878–'84 and are in good condition.

Depth of water.—Soundings taken June 2, 1887, show a least depth of water at the entrance of 15.7 feet, and 14 feet or over thence to the canal.

Operations during the fiscal year.—Not any.

Remarks and recommendations.—As stated in previous reports, the advantages expected to accrue to vessels navigating Lake Michigan, when the construction of a harbor of refuge at this place was projected, have not been entirely realized. In tempestuous weather the harbor is too limited and does not afford sufficient security to vessels seeking its shelter, often necessitating their passage through the canal to avail themselves of the superior advantages afforded by the natural harbor of Sturgeon Bay.

Tolls are exacted by the canal company from vessels using the canal either as an avenue of safety or for purposes of trade. As the construction by the United States of a harbor of refuge at the lake entrance of the canal is a direct benefit to the canal itself, it would seem no more than just that vessels seeking safety in the harbor and compelled to pass through the canal to secure such safety should be exempt from paying toll to the canal company. It is therefore recommended that such legislation be accomplished as shall render the canal free to vessels that may be compelled to use it through stress of weather.

As the pier construction is completed and no dredging required at present, it is probable that the available balance is sufficient for repairs and maintenance; therefore no appropriation is asked for the ensuing year.

Estimated cost (see Report of Chief of Engineers 1874, Part I, page 141)	$180,000
Appropriated	165,000

Commercial statistics for the calendar year 1887 have not been received and the statistics for the year 1885 are used, as they are the latest at hand.

Money statement.

July 1, 1887, amount available	$4,027.71
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	387.29
July 1, 1888, balance available	3,640.42

COMMERCIAL STATISTICS.

Name of harbor, harbor of refuge at entrance of Sturgeon Bay Canal, Wisconsin. Collection district, Milwaukee, Wis. Nearest light-house, entrance to harbor.

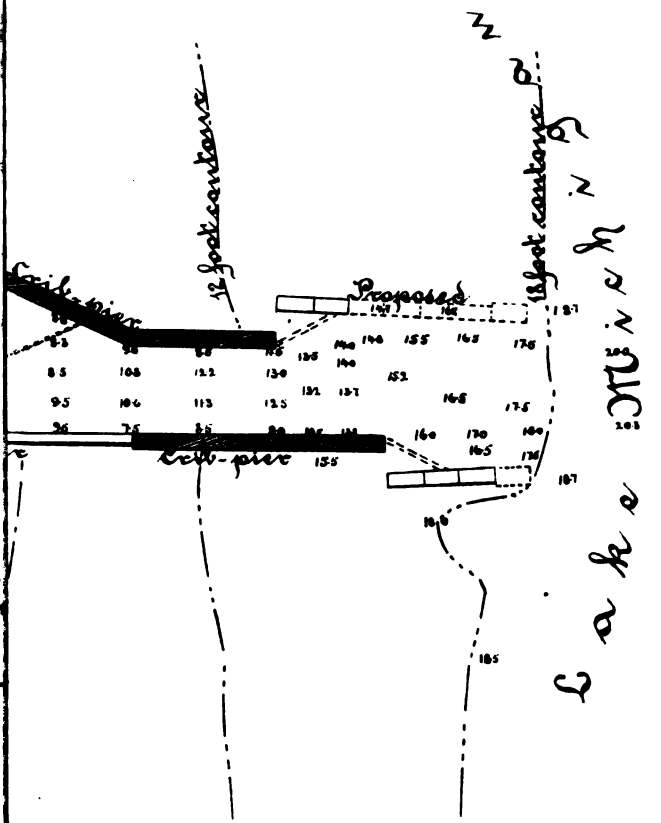
Number of vessels and their tonnage which passed through and sought refuge at the Sturgeon Bay and Lake Michigan Ship-Canal, during the calendar year 1885.

	Number.	Tonnage.
From Lake Michigan to Green Bay	2,515	442,701
From Green Bay to Lake Michigan	1,006	225,810
In canal for refuge	189	25,637
Total	3,710	694,148

G G 14.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

.—To secure a small artificial harbor for local purposes in Wo
ith a navigable channel leading thereto from Lake Michigan.
t.—The project of improvement adopted in 1875 provided fo
ation of a small artificial harbor connected with the lake by
100 feet wide and 12 feet deep, to be formed by the constru
wo piers extending from the shore-line to the 13-foot contour i
; also for blasting and dredging rock from the river-bed nea
h for a distance of 750 feet.
ordance with a modification of the original project approve
ber 27, 1884, the cribs sunk in extension of the piers have bee
0 feet further from the center line of the channel than the old
d will afford, when completed, a 200-foot entrance between th
ds.
t works.—(1) North pier, 902 feet in length, composed of 352 feet
ier, 320 feet of which is 14 feet wide and 32 feet 20 feet wide;
) feet of cribs 20 feet wide. (2) South pier, 1,125 feet in length
d of 625 feet of pile-pier 14 feet wide and 500 feet of cribs 20
e.
ile-piers were built 1871–1874 and are in a fair condition. The
s were built 1875–1884. Four hundred and fifty feet of the north
feet of the south are completed and in good condition, the re-
100 feet of the north and 150 feet of the south pier are without
ucture, and one crib 50 feet in length was moved several feet
osition by ice pressure in April, 1888.
of water.—Originally 2 feet. Soundings made in July, 1885,
e least depth at entrance to be 12.7 feet, and a narrow but avail-
nnel thence up to the bridge of about 7 feet in depth.
tions during the fiscal year.—Owing to a proviso in the appro-
act of August 5, 1886, that wharfage over the Government piers
made free, no work has been done during the fiscal year end-
e 30, 1888.
rks and recommendations.—From the commencement much trouble
n experienced in carrying on the work at this harbor, owing to
that a private party claims to own the entire site of the harbor
piers up to the highway bridge. This man was the owner of
g-pier, from which he derived a handsome revenue before the
ment undertook the improvement of the harbor. He has built
ouse just in the rear of the south pier, and has continued to
s own charges for all goods shipped by the steamer which stops
ree times a week. As Ahnapee has no railroad communication,
his man claims to own the land on both sides of the river, no
reach the piers except as he may direct.
as been the subject of various official reports (see Ex. Doc. No.
use of Representatives, Forty-eighth Congress, second session;
nual Reports of Chief of Engineers for 1877, 1878, and 1885).
s doubtless due to those reports that the river and harbor act of
5, 1886, appropriating $15,000 for continuing the improvement
pee Harbor, contained a proviso that none of the money so ap-
ed should be expended until wharfage over the Government
ould be made free.



To accompany my annual report for fiscal year ending June 30, 1888.

Chas. E. L. B. Davis,
Major of Engineers.

Eng50

G G 14.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

Object.—To secure a small artificial harbor for local purposes in W River with a navigable channel leading thereto from Lake Michigan.

Project.—The project of improvement adopted in 1875 provided f the formation of a small artificial harbor connected with the lake by channel 100 feet wide and 12 feet deep, to be formed by the constru tion of two piers extending from the shore-line to the 13-foot contour the lake; also for blasting and dredging rock from the river-bed ne its mouth for a distance of 750 feet.

In accordance with a modification of the original project approv September 27, 1884, the cribs sunk in extension of the piers have be placed 50 feet further from the center line of the channel than the piers, and will afford, when completed, a 200-foot entrance between t pier-heads.

Present works.—(1) North pier, 902 feet in length, composed of 352 f of pile-pier, 320 feet of which is 14 feet wide and 32 feet 20 feet wid also, 550 feet of cribs 20 feet wide. (2) South pier, 1,125 feet in leng composed of 625 feet of pile-pier 14 feet wide and 500 feet of cribs feet wide.

The pile-piers were built 1871–1874 and are in a fair condition. T crib-piers were built 1875–1884. Four hundred and fifty feet of the no and 350 feet of the south are completed and in good condition, the maining 100 feet of the north and 150 feet of the south pier are with superstructure, and one crib 50 feet in length was moved several f out of position by ice pressure in April, 1888.

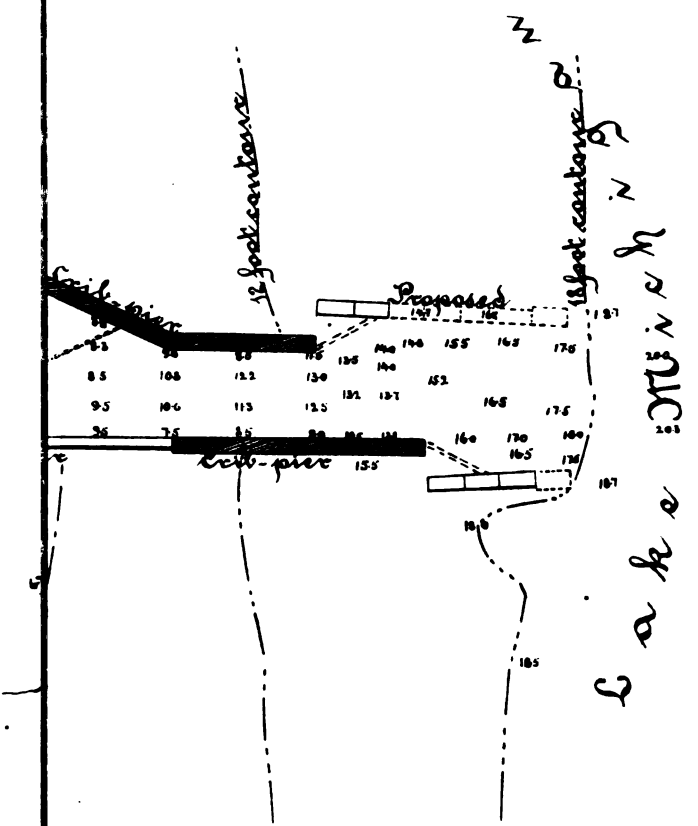
Depth of water.—Originally 2 feet. Soundings made in July, 18 show the least depth at entrance to be 12.7 feet, and a narrow but av able channel thence up to the bridge of about 7 feet in depth.

Operations during the fiscal year.—Owing to a proviso in the app priation act of August 5, 1886, that wharfage over the Government pi must be made free, no work has been done during the fiscal year e ing June 30, 1888.

Remarks and recommendations.—From the commencement much trou has been experienced in carrying on the work at this harbor, owing the fact that a private party claims to own the entire site of the har from the piers up to the highway bridge. This man was the owne a landing-pier, from which he derived a handsome revenue before Government undertook the improvement of the harbor. He has bu a warehouse just in the rear of the south pier, and has continued make his own charges for all goods shipped by the steamer which st there three times a week. As Ahnapee has no railroad communicati and as this man claims to own the land on both sides of the river, one can reach the piers except as he may direct.

This has been the subject of various official reports (see Ex. Doc. 259, House of Representatives, Forty-eighth Congress, second sessi also Annual Reports of Chief of Engineers for 1877, 1878, and 1885).

It was doubtless due to those reports that the river and harbor act August 5, 1886, appropriating $15,000 for continuing the improvem of Ahnapee Harbor, contained a proviso that none of the money so propriated should be expended until wharfage over the Governme piers should be made free.



To accompany my annual report for fiscal year ending June 30, 1888.

Chas. E. L. B. Davis,
Major of Engineers.

Eng5

efforts of the citizens for free wharfage have been unsuccessful, nsequently there have been no operations carried on at this har- ring the past fiscal year.

84, two cribs were sunk in extension of the north pier and three nsion of the south pier. These cribs are 50 feet further from the line of the channel than the old piers, and, having no super- re, are very dangerous obstructions.

very desirable that work at this harbor should be resumed, and ecommended that the proviso about free wharfage be omitted ture appropriations, as, after the channel has been excavated the present site of the bridge, steamers can land above the limits land now claimed by the owner of the warehouse, and his mo- will then be ended.

d cost (see Report of Chief of Engineers for 1876, Part II, pages 9)	$175,000
iated	155,000

Money statement.

887, amount available	$15,433.42
888, amount expended during fiscal year, exclusive of liabilities nding July 1, 1887	158.80
888, balance available	15,274.62
appropriated by act of August 11, 1888	5,000.00
available for fiscal year ending June 30, 1889	20,274.62
nt (estimated) required for completion of existing project	15,000.00
nt that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

tted in compliance with requirements of sections 2 of river and or acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDER YEAR 1887.

[Furnished by M. T. Parker, esq.]

of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest light- turgeon Bay Canal, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
	280	80,050	280	80,050
	330	88,960	327	88,840
l	610	169,010	607	168,890

Principal articles of export and import.

Articles.	Appr w
EXPORTS.	
Cheese, butter, and eggs	
Wheat, oats, pease, barley, and hay	
Shingles, lath, and lumber	
Railroad ties, posts, bark, and wood	
Fresh fish and salt fish	
Live stock	
Potatoes, wool, rags	
General merchandise	
Total	
IMPORTS.	
Shingles, lath, and lumber	
Leather and hides	
Coal, iron, steel, etc	
Sash, doors, blinds, etc	
Wagons, sleighs, agricultural implements, etc	
General merchandise	
Total	

Amount of revenue collected, none.

G G 15.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan int waunee River, which is the harbor of Kewaunee.

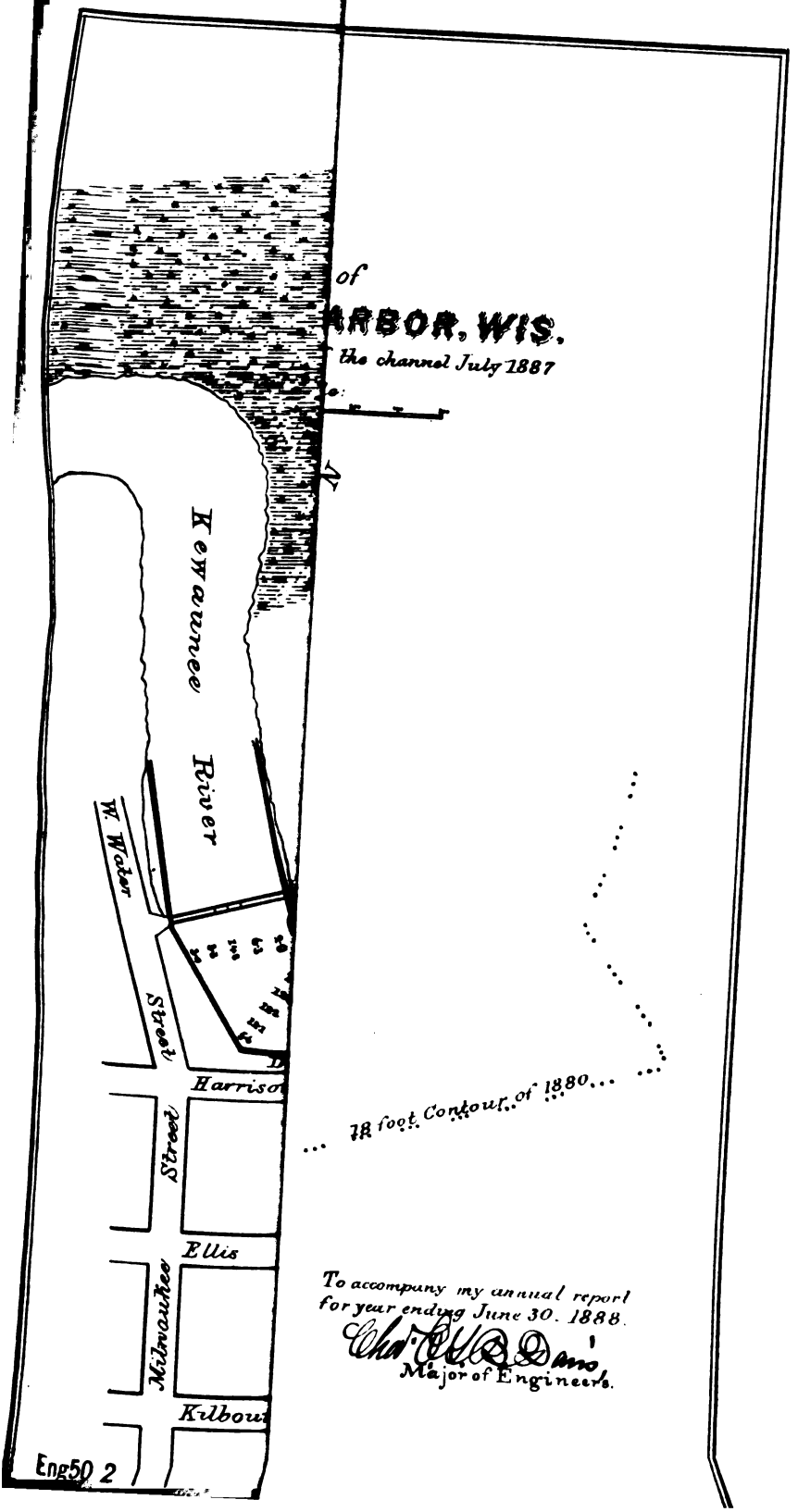
Project.—The project of improvement adopted in 1881 and now in is for the formation of a channel from a point about 2,000 feet sou the mouth of the Kewaunee River through a spit about 300 feet affording communication between the river and Lake Michigan. the lake end of this cut two parallel piers 200 feet apart are to be structed, extending to the 18-foot contour, with dredging betwee through the cut to a depth of 14 feet.

Present works.—Pile-piers lined with sheet-piling. (1) The nort is 1,000 feet long and 16 feet wide. (2) The south pier is 775 feet and 16 feet wide. They were built 1881–1887 and are in good cond

Depth of water.—Originally 2 feet. Soundings made in July, show 9 feet depth of water at the entrance and a channel betwee piers about 100 feet wide, with a depth of from 10 to 12 feet. Th river-bed north of the new entrance has also been dredged, form basin 475 feet long, 150 feet wide, and 10 feet deep.

Operations during the fiscal year.—Under contract dated Octob 1886, with Messrs. Schwarz & Berner, of Green Bay, Wis., for ex ing the north pile-pier 300 feet, work was in progress, and 100 feet same had been completed at the beginning of the fiscal year. T maining 200 feet were completed during the fiscal year, and the co closed August 6, 1887.

By hired labor and open purchase 15.3 cords of stone were plac the north side of the north pier at its junction with the beach to pr a breach that appeared imminent at that point.


of
ARBOR, WIS.
the channel July 1887
Kewaunee River
W. Water Street
Harrison Street
Ellis
Milwaukee Street
Kilbourn
18 foot Contour of 1880
To accompany my annual report
for year ending June 30. 1888.
Chas. E. L. B. Davis
Major of Engineers.

Eng50 2

Remarks and recommendations.—It is doubtful if the local business at this harbor would in itself justify the completion of the improvement. It will, however, afford protection for vessels in stress of weather, and as a harbor of refuge its completion is desirable.

Should an appropriation be made for the fiscal year ending June 30, 1890, it is contemplated to expend it in further pier construction, dredging, and repairs to the present piers, if necessary.

Materials used in building 300 linear feet of pile-piers, and their cost in place, under contract of Messrs. Schwarz & Berner, of Green Bay, Wis., dated October 19, 1886.

10,822 linear feet round piles, at 18 cents	$1,947.96
18,574 feet, B. M., white-oak timber, at $48 per M	891.55
44,565 feet, B. M., Norway sheet-piling, at $28 per M	1,247.82
3,004 feet, B. M., pine plank, at $14 per M	42.05
615 linear feet pine timber, 6 by 12, at 15 cents	92.25
518 linear feet pine timber, 12 by 12, at 24 cents	124.32
7,975.2 pounds of iron screw-bolts and tie-rods, at 4¾ cents	378.82
936 pounds of spikes, at 4½ cents	42.12
442.5 cords stone, at $4.95	2,091.37
	6,858.26
Cost per linear foot	22.86
Estimated cost (see Report of Chief of Engineers for 1881, page 2084)	200,000.00
Appropriated by the United States	45,000.00
Appropriated by local authorities	8,042.72
Total	53,042.72

Money statement.

July 1, 1887, amount available	$7,658.84
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,469.47
July 1, 1888, balance available	189.37
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,189.37
Amount (estimated) required for completion of existing project	136,937.28
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by J. E. Lathrop, inspector.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Twin River Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Steam	199	60,971	199	60,971
Sail	215	18,734	212	18,498
Total	414	79,705	411	79,469

Principal articles of export and import.

Articles.	Appr va
EXPORT.	
Grain	
Railroad ties, bark, wood, shingles, piles	
Butter, chese, eggs, poultry, etc	
Flour, feed, and bran	
Hay and potatoes	
Total	
IMPORT.	
Fruit and beer	
General merchandise	
Agricultural implements	
Lard, plaster, salt, oil, and coal	
Total	

Amount of revenue collected, none.

G G 16.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Rivers, where the harbor of Two Rivers is situated.

Project.—The project for the improvement of this harbor, adopt 1870, provided for the construction of two parallel piers extending the river-mouth to the 18-foot contour in Lake Michigan, and drec between them to a depth of 12 feet.

Present works.—Pile and crib piers: (1) North pier 1,810 feet composed of 1,060 feet of pile-pier 14 feet wide and 750 feet of cri feet wide. (2) South pier 1,710 feet long, composed of 960 feet of pier 14 feet wide and 750 feet of cribs 20 feet wide. The pile-piers built 1871–1874 and the cribs 1875–1884. The latter are in good dition, but some filling and repairing will be required to the pili an early date.

Depth of water.—Originally from 2 to 3 feet.

At the close of dredging in September, 1885, the channel had a of 12 feet and a width of about 180 feet.

Since then no work has been done, and considerable filling has place.

In May, 1887, it was reported that a narrow channel existed of cient depth to admit vessels drawing 10 feet.

Operations during the fiscal year.—None.

Remarks and recommendations.—It is not deemed necessary to ur immediate completion of the original project, which would requi extension of the north pier of about 400 feet and of the south p about 500 feet.

The commerce of this harbor is merely nominal, nearly all the fr ing being done by rail. The improvement has, however, furnish inside landing-place for what commerce there is, a great advantage piers extending from the shore into the open lake.

The removal of about 20,000 cubic yards of material is necess

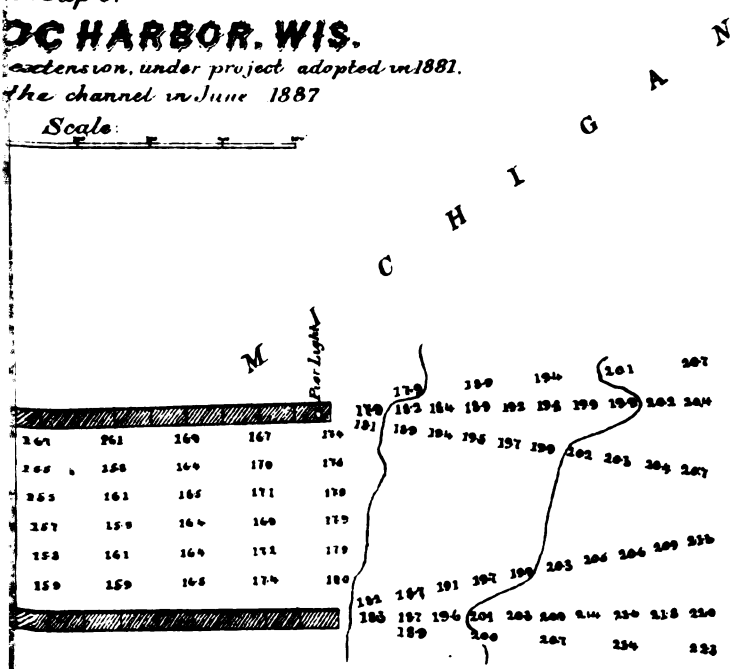
Map of

OC HARBOR, WIS.

extension, under project adopted in 1881.

the channel in June 1887

Scale:



To accompany my annual report
for year ending June 30. 1888.

Chas. E. L. B. Davis,
Major of Engineers.

in 1881. There is no outer bar, and further pier extension is u sary.

A portion of the superstructure is in bad condition, about 1,00(feet being from seventeen to twenty-one years old. All of th soon require rebuilding, and, commencing at the head of the sou should be rebuilt above the water line at once.

With this exception the piers are in good condition.

There has been no dredging since June, 1883. The removal o 20,000 cubic yards of material is necessary to provide a safe e to the improved channel made by the local authorities in the riv

This will be done this season if an appropriation is made.

No additional estimate is deemed necessary at present, as th mated amount required for the completion of the existing (($16,362.54) will probably be sufficient.

This is one of the most important harbors on Lake Michigan, n Milwaukee. The ship-yards and machine-shops have diverted erable trade from Chicago and Milwaukee, the owners of many preferring to have them repaired at Manitowoc than at othe ports.

There is considerable local commerce, and large numbers of seek refuge here during storms.

The appropriation of $16,000 asked for is to applied to rebuil part of the superstructure, and dredging.

Cost of materials in place, used in the construction of five cribs, each 59 by 24 by and 250 feet of superstructure upon the same, averaging 4 feet in height, under with Messers. Truman & Cooper, dated October 19, 1886.

14,876 linear feet pine timber, at 23 cents	$
14,234 linear feet hemlock timber, at 20 cents	
18,156 feet, B. M., pine plank, at $15 per M	
24,065.3 pounds drift-bolts, at 3 cents	
4,750 screw-bolts, at 4 cents	
627 pounds spikes, at 4 cents	
1,061.93 cords stone, at $6	
	1
Cost per linear foot of substructure	
Cost per linear foot of superstructure	
Estimated cost (see Report of Chief of Engineers, 1881, page 2094)	30
Appropriated	29

Money statement.

July 1, 1887, amount available	$
Received from sale of fuel to officer	
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	
July 1, 1888, balance available	
Amount appropriated by act of August 11, 1888	
Amount available for fiscal year ending June 30, 1889	
Amount (estimated) required for completion of existing project	
Amount that can be profitably expended in fiscal year ending June 30, 1890	

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

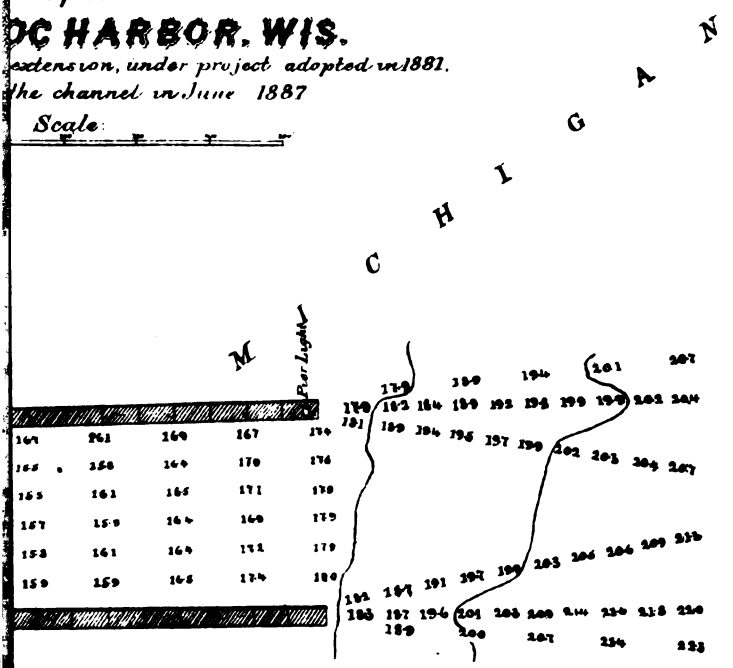
Map of

OC HARBOR, WIS.

extension, under project adopted in 1881.

the channel in June 1887

Scale:



To accompany my annual report
for year ending June 30. 1888.

Chas. E. L. B. Davis,
Major Engineers.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by Edward Conway, deputy collector of customs.]

) of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest ouse, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
.....	860	341,500	864	342,838
.....	525	82,756	528	83,868
tal	1,385	424,256	1,392	426,706

Principal articles of export and import.

Exports.	Value.*	Imports.	Value.*
and other products.....	$500,000	Coal	$400,000
.....	300,000	Lumber.....	200,000
.....	400,000	Groceries	150,000
.....	400,000	Dry goods	400,000
.....	300,000	Iron and hardware	300,000
.....	100,000	Farm machinery.....	200,000
.....	200,000	Other merchandise	300,000
.....	50,000		
tal	2,250,000	Total	1,950,000

* Approximate.

int of revenue collected, none.

G G 18.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

ct.—To secure a navigable channel from Lake Michigan into the r of Sheboygan, at the mouth of the Sheboygan River.

ect.—The project for the improvement of this harbor was adopt- 1852, and had for its object the formation of a 12-foot channel ice to the mouth of the Sheboygan River. This was modified in o as to secure a deeper channel by further pier extension and ing. Both projects were completed within their estimated cost, channel was formed 100 feet wide, with a depth of 15 to 16 feet en the piers. A survey made in 1880 showed a depth of less than t between the piers and on the outer bar. The existing project lopted in 1881, its object being to deepen the channel still further ending the piers to the 20-foot contour in the lake and dredging epth of 18 feet between their outer ends, the depth decreasing to t at the shore-line.

ent works.—(1) North pier, 2,044 feet long, composed of 900 feet of

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by Edward Conway, deputy collector of customs.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	860	341,500	864	342,838
Sail	525	82,756	528	83,868
Total	1,385	424,256	1,392	426,706

Principal articles of export and import.

Exports.	Value.*	Imports.	Value.*
Leather and other products	$500,000	Coal	$400,000
Grain	300,000	Lumber	200,000
Peas	400,000	Groceries	150,000
Flour	400,000	Dry goods	400,000
Cheese	300,000	Iron and hardware	300,000
Butter	100,000	Farm machinery	200,000
Cattle	200,000	Other merchandise	300,000
Horses	50,000		
Total	2,250,000	Total	1,950,000

* Approximate.

Amount of revenue collected, none.

G G 18.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the harbor of Sheboygan, at the mouth of the Sheboygan River.

Project.—The project for the improvement of this harbor was adopted in 1852, and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost, and a channel was formed 100 feet wide, with a depth of 15 to 16 feet between the piers. A survey made in 1880 showed a depth of less than 12 feet between the piers and on the outer bar. The existing project was adopted in 1881, its object being to deepen the channel still further by extending the piers to the 20-foot contour in the lake and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore-line.

Present works.—(1) North pier, 2,044 feet long, composed of 900 feet of

pile and crib pier, built by the city, from 12 to 20 feet wide; 1,0[illegible] feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide. (2) Sou[illegible] pier, 2,260 feet long, composed of 780 feet of pile and crib pier, bu[illegible] by the city, from 12 to 20 feet wide; 132 feet of pile-pier 20 feet wid[illegible] 1,298 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide, bu[illegible] 1852–'87. About 700 feet of each pier built since 1871 is in good co[illegible] dition, the cribs having been sunk on a stone or pile foundation. Pre[illegible] vious to 1871 they were sunk on the natural lake bottom, composed o[illegible] shifting sand and causing them to settle very unevenly.

Depth of water.—Originally 4 feet, now a navigable channel with [illegible] depth of about 13 feet.

Operations during the fiscal year.—Under contract dated October 19, 1886, with Messrs. Truman & Cooper, of Manitowoc, Wis., the north pier was extended 200 feet by four cribs, each 50 by 20 by 18½ feet, including superstructure. They were placed on foundations consisting of twenty-four piles for each crib. Work began July 12 and the contract was closed October 11, 1887.

By hired labor, dredging, which was in progress with United States Dredge No. 2 at the beginning of the fiscal year, was continued until July 12, and then suspended for the season. In July, 4,410 cubic yards of material were removed from the channel, making a total for the season of 14,485 cubic yards. Two cuts were made north of the center line of the channel; Cut No. 1 was 35 feet wide and 1,750 feet long; Cut No. 2, 30 feet wide and 950 feet long.

Remarks and recommendations.—As stated in previous reports, dredging affords but temporary relief, as, owing to the open character of the old crib-pier, large quantities of sand pass through the piers and are deposited as a bar near the entrance.

This bar has been a great impediment to commerce, and it is thought that no permanent improvement can be obtained until the piers have been extended over the bar into deep water. It may also be necessary to render the older portion of the piers sand-tight by means of some kind of revetment. In view of the above facts a sufficient amount of money should be made available to permit the rapid extension of the piers.

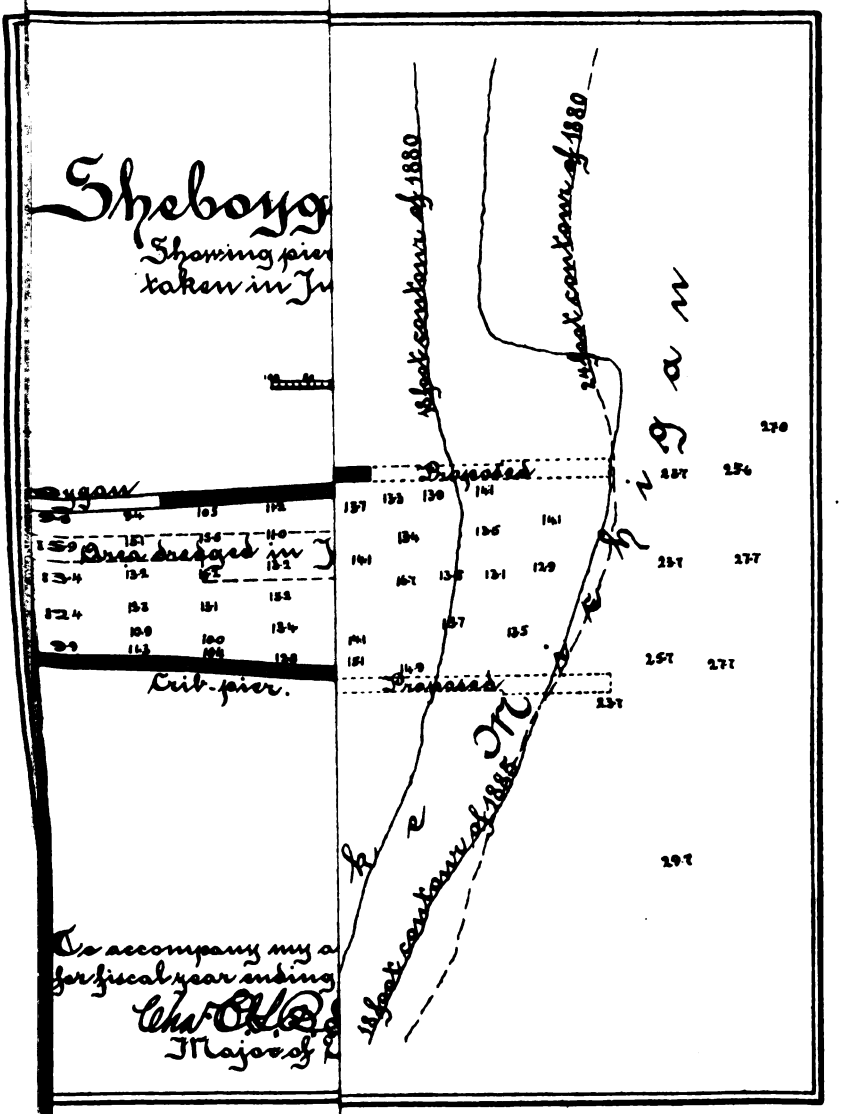
The local commerce is large, and this harbor would be extensively sought for shelter if the depth was sufficient for vessels to enter safely.

To complete the project 750 linear feet of crib-piers remain to be built and about 69,000 cubic yards of material to be removed by dredging.

The condition of the shore end of the south pier is such, that it must be extensively repaired or entirely rebuilt in the near future. For 150 feet outside the present shore-line, and for about the same distance inside, the superstructure is badly rotted and burned away, so that sand is driven through into the channel to such an extent that the shore-line has slightly receded, though in the forty years preceding 1879 it had advanced over 300 feet.

There is some doubt as to the responsibility for the care of this part of the work. It was occupied for several years by the Sheboygan and Fond du Lac Railroad Company as a wharf-front. Their warehouse and dock burned down a few years ago, and have not been rebuilt. It is probable that the needed repairs must be made by the United States, if they are made at all.

With the appropriation asked for for the fiscal year ending June 30, 1890, it is proposed to continue the pier extension and dredging and to make some repairs to the piers.


Sheboyg
Showing pier
taken in Ju
Area dredged in J
Crib-pier.
Proposed
Proposed
18 foot contour of 1880
24 foot contour of 1880
18 foot contour of 1885
Mishigan
To accompany my a
for fiscal year ending
Major of

ost of materials in place used in the construction of 4 cribs, each 50 by 20 by 18½ linear feet, including superstructure, extending the north pier 200 feet, under contract with Messrs. Trumen & Cooper, dated October 19, 1886.

),330 linear feet pine timber, at 27 cents	$2,789.10
798 linear feet hemlock timber, at 23 cents	2,023.54
,816 feet, B. M,, pine plank, at $15 per M	192.24
5.85 cords stone, at $6.50	5,179.52
309.2 pounds drift-bolts, at 3 cents	459.28
86 pounds screw-bolts, at 4 cents	159.44
5 pounds spikes, at 4 cents	19.04
piles, at $8	768.00
	11,590.16
st per linear foot of substructure	46.48
st per linear foot of superstructure	11.46
imated cost (see Report of Chief of Engineers, 1881, page 2104)	150,000.00
ditional estimate (Annual Report of Chief of Engineers, 1884, page 1856)	45,000.00
Total	195,000.00
propriated	98,000.00

Money statement.

ly 1, 1887, amount available	$13,521.79
ly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,892.44
ly 1, 1888, balance available	629.35
ount appropriated by act of August 11, 1888	15,000.00
ount available for fiscal year ending June 30, 1889	15,629.35
Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by Mr. E. P. Ewer.]

Name of harbor, Sheboygan, Wis. Collection district, Milwaukee, Wis. Nearest ght-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
team	485	303,226	484	303,513
ail	634	55,564	640	55,898
Totals	1,119	358,790	1,124	359,411

me and stone	
er and beer supplies	
gs	
eese	
ots and shoes	

IMPORTS.

General merchandise	
Lumber	
Coal	
Tan-bark	
Wood	
Stone cement	
Wine and liquor	
Varnish, paint, and oil	
Hides and tannery supplies	
Pig-iron	
Hay and grain	

Amount of revenue collected, none.

G G 19.

IMPROVEMENT OF PORT WASHINGTON

Object.—To secure a small artificial harbor basins connected with each other and a thereto from Lake Michigan.

Project.—The present project for the im adopted in 1869 and modified in 1870 and by dredging, of two interior basins, having acres, with a depth of 12 feet and a channel ing them with the lake, the channel entran of the mouth of the Sauk River, inclosed structed that the flow of the river should t nel and that the débris brought down by fr the channel, should re-en

ırstructure, 24 feet wide and 7 feet in height above datum, were built ı Crib No. 17, north pier, in August, 1888, and the contract closed.

ɜmarks and recommendations.—No further extension of the north is contemplated.

ı complete the project the south pier should be extended 100 feet about 50,000 cubic yards of material removed by dredging. This meet the present and prospective demands of commerce.

ıibs Nos. 8 and 9 of the north pier require additional stone filling and king.

ıe piers are short and the character of the lake bottom hard; there- the probable cost of maintenance will be small.

ghty-five and three-fourths per cent. of the dredging is completed 95.5 per cent. of the pier construction.

ith the money asked for for the fiscal year ending June 30, 1890, it is osed to complete the project by pier construction and dredging.

ıated cost (see Report of Chief of Engineers, 1877, page 866)	$154,527.17
ıional estimate (Report of Chief of Engineers, 1880, page 1922)	27,000.00
	181,527.17
ɔpriated	169,500.00

Money statement.

ı, 1887, amount available	$2,216.53
1, 1888, amount expended during fiscal year, exclusive of liabilities standing July 1, 1887	1,177.16
1, 1888, balance available	1,039.37
ınt appropriated by act of August 11, 1888	5,000.00
ınt available for fiscal year ending June 30, 1889	6,039.37
ıount (estimated) required for completion of existing project	7,000.00
ıount that can be profitably expended in fiscal year ending June 30, 1890.	7,000.00

bmitted in compliance with requirements of sections 2 of river and ıarbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1887.

[Furnished by James McCarthy, harbor-master.]

me of harbor, Port Washington, Wis. Collection district, Milwaukee, Wis. est light-house, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
.....	26	4,800	26	4,800
.....	253	17,950	253	17,950
Totals	279	22,750	279	22,750

IMPORTS.

Pig-iron and coal	
Lumber, laths, shingles, and cord-wood	
Hides	
Barley, rye, corn, and oats	
Tan-bark	
General merchandise	
Total	

Amount of revenue collected, none.

APPENDIX H H.

RUCTION OF HARBOR OF REFUGE, MILWAUKEE BAY—IMPROVE-
OF THE HARBORS OF MILWAUKEE, RACINE, AND KENOSHA, WIS-
IN, AND WAUKEGAN, CHICAGO, AND CALUMET, ILLINOIS—IM-
EMENT OF ILLINOIS, CALUMET, FOX, AND WISCONSIN RIVERS.

T OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER HARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH R DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

or of Refuge, Milwaukee Bay, consin.
aukee Harbor, Wisconsin.
e Harbor, Wisconsin.
ha Harbor, Wisconsin.
egan Harbor, Illinois.
nd Wisconsin rivers.
7. Operating and care of locks and dams on the Fox and Wisconsin rivers.
8. Chicago Harbor, Illinois.
9. Calumet Harbor, Illinois.
10. Illinois River, Illinois.
11. Calumet River, Illinois and Indiana.
12. Surveys for Hennepin Canal.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 10, 1888.

I have the honor to transmit herewith annual reports upon the n my charge during the fiscal year ending June 30, 1888.
works of Chicago Harbor, Calumet Harbor, Illinois River, Illi- Calumet River, Illinois and Indiana; and surveys for Hennepin were in charge of Maj. Thos. H. Handbury, Corps of Engineers e beginning of the year to March 31, 1888.
Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

CHIEF OF ENGINEERS, U. S. A.

H H 1.

HARBOR OF REFUGE AT MILWAUKEE BAY, WISCONSIN.

CONDITION OF WORK JUNE 30, 1888.

e close of the fiscal year ending June 30, 1887, the breakwater n extended 3,200 feet, over 500 linear feet of which superstruct- not been built.
ng the past fiscal year 100 linear feet of the substructure, con- of two 50 feet by 24 feet by 22½ feet cribs, have been completed,

and superstructure built over 400 linear feet of substructure previously completed.

There remains to be constructed 3,950 linear feet of substructure and 4,150 linear feet of superstructure to complete the improvement.

The harbor is becoming available, to a limited extent, as a harbor of refuge during northerly storms, and a point is now reached in its development when its sheltered area is more rapidly extended than heretofore as work progresses.

The last appropriation for this work combined the harbor of refuge, Milwaukee Bay, and Milwaukee Harbor. Of the amount appropriated an allotment sufficient, with the balance remaining on hand from former appropriations for Milwaukee Harbor, to rebuild the superstructure over the outer section of the north pier of Milwaukee Harbor was made by the War Department.

This amount, $4,737.91, should be deducted from the amounts heretofore appropriated for this work and added to those made for Milwaukee Harbor, as it has not been available for the harbor of refuge, Milwaukee Bay.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURES DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

All funds now available will be required for lighting the breakwater during the present season of navigation. Any further appropriations that may be made applicable to the work during the fiscal year will be expended in extending the east arm of the breakwater southward.

PROPOSED APPLICATION OF FUNDS ASKED FOR FISCAL YEAR ENDING JUNE 30, 1890.

The funds asked for are to be used to extend the main arm of the breakwater southward and to complete the superstructure over the work as far as it will then have been built, including a section of permanent iron and concrete superstructure already authorized as an experimental construction by the Engineer Department, U. S. Army.

It is hoped that the next appropriation may be of sufficient magnitude to allow the work to be advanced far enough to meet to an appreciable extent the needs of navigation for a harbor of refuge.

This harbor is of use to the general commerce of the Lakes, including that between Lake Michigan ports and the other Great Lakes.

A statement of the amount of commerce, which is increasing, may be found in Colonel Houston's report, published in House Ex. Doc. No. 43, Forty-sixth Congress, third session; also in the reports on Chicago and Milwaukee harbors in the Annual Report of the Chief of Engineers, 1887, Appendices H H and I I.

A detailed tabulated statement of the cost of each crib and its foundation, in this work, is given in the Annual Report of the Chief of Engineers for 1887, page 2059.

Money statement.

July 1, 1887, amount available	$39,754.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887, and including $4,737.91, expended on Milwaukee Harbor	36,116.35
July 1, 1888, balance available	3,638.23
Amount appropriated by act of August 11, 1888	70,000.00
Amount available for fiscal year ending June 30, 1889	73,638.23

Amount (estimated) required for completion of existing project.....$418,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1888.

SIR: I have the honor to submit the following report upon the harbor of refuge, Milwaukee Bay, Wisconsin, for the fiscal year ending June 30, 1888.

At the close of the year ending June 30, 1887, there remained to be built and sunk in position under the contract of Messrs. Hiero B. Herr & Co., of date September 29, 1886, two cribs, Nos. 59 and 60, each of dimensions 50 feet by 24 feet by 22½ feet; and of superstructure, a length of 400 feet, to be built over cribs, numbering from 49 to 56, inclusive.

Crib No. 59 was sunk on the 27th of July, 1887, and Crib 60 on the 29th of the same month. The superstructure was completed to a height of 6 feet above datum, and the requisite quantity of stone ballast was placed in the work.

An attempt was made by the contractors to sink the above-mentioned cribs together, and with a view to this purpose, they were connected at top by timbers bolted to the sides. They were towed from the Milwaukee River to the breakwater together, and placed in proper position for sinking.

The weather was favorable for the purpose, and about 20 men were at work upon the connected cribs, adjusting the stone ballast used for settling them down upon the foundation. When about 15 cords of stone had been transferred to the temporary decking of the cribs, it was discovered that the connecting timbers were bearing upon one of the large scows; the scow was suddenly released by the insertion of a wedge, and the crib immediately toppled over, and discharged the partial deck-load of stone, seriously imperiling the workmen, all of whom, however, escaped without serious injury. This incident is mentioned for the reason of its having led to the consideration of a method for sinking cribs of 100 or more feet in length, whereby a counterpoise to the deck-load can be used. In the future extension of the breakwater, it is proposed to use cribs of 100 feet in length, the berme of the stone foundation to be widened on the inner side, and raised to a height of 4 feet above the bottom of the cribs when placed on top of the foundation in 20 feet of water.

By your direction, I drew a plan of crib of dimensions 100 feet by 24 feet by 22½ feet. The counterpoise of stone ballast is to be placed upon a platform of boards 1 inch in thickness, fastened upon the longitudinal grillage timbers, in four of the pockets of the cribs. In each of these pockets about 2½ cords of stone can be placed, which will assist in balancing the crib while being settled into position. When the pockets are filled with stone it is probable that the boards will be crushed and the stone permitted to pass through the grillage.

As soon as practicable after the cribs 59 and 60 were completed, soundings were taken on cross-sectional lines, at distances of about 7 feet apart, which covered the whole area of the foundations of cribs sunk under the contract of Messrs. Herr & Co., the spaces between soundings on the lines being 2 feet. The length of the breakwater is now 3,300 linear feet, of which 200 feet requires to be furnished with superstructure.

An extensive deposit of sand has been made in the northern section of the harbor. A survey of the accretions which have formed above the water-line, together with a comparison of the depths of water which prevailed on lines common to the surveys of 1883 and 1887, shows the deposit to be about 258,000 cubic yards, as stated in special report submitted upon this subject on November 7, 1887. The anchorage area in the harbor has not yet been very seriously encroached upon, nor is inconvenience from this cause to be immediately apprehended. If, however, there should be no diminution in the volume of deposit, the area will be appreciably diminished in the course of a few years. The authorities of the city of Milwaukee are now constructing a tunnel for the purpose of flushing the Milwaukee River, and it is their intention to take the water from the northern section of the harbor of refuge; they have established a site for the pumping works upon the accretions already formed along the shore.

The services of the scow *Dunham* were continued as a light-ship at the southern extremity of the breakwater until the close of navigation in 1887. The same vessel

is employed for the purpose during the present season of navigation, her owner being the lowest competitive bidder for maintaining the light.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. Army.

COMMERCIAL STATISTICS.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis. Amount of revenue collected from customs at the nearest port of entry during the last fiscal year is $305,828.09.

H H 2.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

CONDITION OF WORK JUNE 30, 1888.

During the fiscal year ending June 30, 1888, the contract entered into September 29, 1886, with Hiero B. Herr & Co., for cutting down and rebuilding superstructure over the outer section of the north pier, was completed and closed, 336 linear feet of superstructure having been rebuilt.

The depth of water between the piers is 17 feet, but the 17-foot channel continues to deteriorate in width. Dredging is needed to restore the channel to 18 feet.

PROPOSED APPLICATION OF FUNDS AVAILABLE AND THOSE ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

There are no funds now available for this harbor.

The funds asked for the fiscal year ending June 30, 1890, are to be applied to the cutting down and rebuilding of the superstructure over the outer section of the south pier; to the protection of this work by guard-piles and bulkhead timbers at the ends of the piers; to repair the pile protection to the stone superstructure of the inner section of the north pier, and to dredge out the harbor entrance to 18 feet below low water.

This harbor is the second in importance on Lake Michigan. The original project is completed, and it is probable that for many years no work beyond maintenance will be required. The superstructure of the piers when repaired should then, to lessen the cost of maintenance, be made permanent by building it of stone or concrete. The superstructure of the inner section of the north pier of this harbor is now of stone and concrete, and is satisfactory. The cost of stone superstructure is much more than that of wood, but it is permanent, and it is hoped that Congress may make appropriations sufficiently liberal to allow the present superstructure to be replaced now with permanent work. The estimates below, however, are based on wooden superstructure. For concrete superstructure this estimate should be increased $15,000 for rebuilding the outer section of the south pier, now rotten.

Money statement.

uly 1, 1887, amount available	$7,901.95
mount allotted from act of August 5, 1886, for Milwaukee Bay and Harbor	4,737.91
	12,639.86
uly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,639.86
mount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1888.

SIR: The following report upon the improvement of Milwaukee Harbor, Wis., is respectfully submitted:

Under the contract of Messrs. Hiero B. Herr & Co., of date September 29, 1886, for cutting down and rebuilding the superstructure of the outer section of the north pier of this harbor, in length 600 feet, about 270 running feet of the section had been rebuilt at the commencement of the fiscal year closing this date.

The whole of the work (which is by actual measurement 606 feet in length) was completed on the 24th day of September, in a very substantial manner, to a height of 7 feet above datum, including also the driving of ninety protection piles. Thirty of these piles were used at the pier-head, and sixty were driven and secured by screw-bolts to the channel-face of the new superstructure, and capped with oak timber 12 inches square.

Forty of the old piles were taken out and removed from the face of the pier.

The trestle-work for carrying the footwalk from the light-house crib to the beacon light, at the extremity of the pier, has been rebuilt under the direction of the Light-House Department.

On the 26th of last month I took soundings in the channel, a plat of which has been submitted.

The depth of water has diminishd somewhat, and the deepest section of the channel has become narrower through the deposit of sediment within the past year. Reports of an insufficient depth of water in the channel have been made, but which seem to have been somewhat exaggerated, as it is yet practicable for vessels having a draught of 16½ feet of water to enter the harbor in moderate weather.

No dredging has been done by the United States Government at this harbor since 1880, and in view of the increase in the size of vessels of recent build, it would benefit navigation if the channel were dredged to the depth of 18 feet, and to a width of 200 feet. This would involve the removal of about 30,000 cubic yards of material.

The superstructure of the outer section of the south pier, 600 feet in length, built in 1871 and 1872, needs to be renewed, and repairs are necessary at the west ends of both the north and south piers. The pile protection to the stone superstructure of the inner section of the north pier needs renewal.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following extract, taken from the annual report of the secretary of commerce for the fiscal year ending April 2, 1888, shows receipts, shipments, and manufactures of some of the leading articles of commerce at the harbor and city of Milwaukee during the year:

Articles.	Quantity and value.	Articles.	Quantity and value.
Receipts.		*Receipts.*	
Barley:		Malt ..... bushels..	3,806,378
Bushels	5,778,663	Mill-stuffs:	
Consumed by brewers, bush..	2,547,937	Receipts ..... tons..	50,763
Beer manufactured ..... barrels..	1,283,432	Shipments ..... do....	89,289
Butter ..... pounds..	7,868,744	Oats, receipts ..... bushels..	3,563,234
Cheese ..... do....	19,603,440	Pig-iron ..... tons..	107,000
Coal:		Potatoes:	
By lake ..... tons..	724,594	Received ..... bushels..	594,996
By rail ..... do....	118,385	Shipped ..... do....	259,099
Cement (manufactured). barrels..	321,000	Salt, received ..... barrels..	469,182
Corn ..... bushels..	918,588	Tobacco, Wisconsin ... pounds..	12,144,949
Eggs ..... packages..	120,873	Tan-bark ..... cords..	30,951
Flaxseed ..... bushels..	1,556,855	Tallow ..... pounds..	1,741,627
Flour:		Wheat ..... bushels..	9,346,756
Manufactured in Milwaukee ..... barrels..	1,214,048	Product of rolling-mills:	
Total receipts ..... do....	3,952,685	Bar-iron ..... tons..	60,297
Fire-wood ..... cords..	84,295	Nails ..... kegs..	78,930
Hides ..... number..	670,658	Pig-iron ..... tons..	63,374
Hogs:		Muck-bar ..... do....	14,740
Received ..... do....	556,048	Receipts of office of internal-revenue	$2,645,726.60
Packed ..... do....	450,106	Post-office receipts	$388,121.02
Hops used by brewers .. pounds..	1,781,824	Post-office, money-order business	$5,214,548.31
Lumber ..... feet, B. M..	299,119,000	Bank deposits	$640,627,112.04
Shingles	69,620,000	Transactions in city real estate.	$8,521,195.00
Cedar posts ..... number..	1,548,076		

The total number of vessels owned and registered at the port of Milwaukee is 132, having an aggregate tonnage of 39,236.45, custom-house measurement.

Craft.	Number.	Tonnage.
Steamers	36	23,351.50
Schooners	76	15,253.64
Tug-boats	19	497.57
Steam-scow	1	133.74
Total	132	39,236.45

	Value.
Sailing vessels, 15,253.64 tons, at $25	$381,341.00
Steam-vessels, 23,982.81 tons, at $60	1,439,968.60
Total value vessel property	1,821,309.60

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis. Amount of revenue collected at this port of entry, $305,828.09.

The arrivals and departures at this port of entry during the fiscal year as given by the collector were as follows:

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	2,603	1,872,974	2,617	1,899,905
Sail-vessels	2,594	487,819	2,406	484,903
Total	5,197	2,360,793	5,023	2,384,808

H H 3.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

CONDITION OF WORK JUNE 30, 1888.

During the past fiscal year no work was done on account of lack of funds. The harbor has deteriorated in depth to 12½ feet in the channel, and is in urgent need of relief by dredging. The funds appropriated from year to year have been less than necessary for maintaining the existing work and channel, so that no progress towards completing the project has been made for several years.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

It is proposed to expend these funds in dredging the 16-foot channel to 150 feet in width and to extending the south pier towards completion. The project for extending the south pier is contained in the Report of the Chief of Engineers for 1883.

The work is necessary for arresting the drift of sand into the harbor and to reduce the funnel-shaped entrance, to prevent disturbance within the harbor by waves entering the present wide mouth. The work of dredging is now necessary, and should be done at the earliest practicable moment.

Money statement.

July 1, 1887, amount available	$774.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	174.56
July 1, 1888, balance available	599.48
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,599.48
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

In their memorial to the Senate and House of Representatives of the United States the merchants, manufacturers, shippers, and other business men of the city of Racine state as follows: "The total value of the freight received by lake in the past year is not less than $2,200,000."

"The capital invested in the various manufacturing enterprises occupying or touching the dock-lines on the river represents many millions of dollars." The value of coal received was $328,500. Of lumber received by one firm, $300,000. The Case Thrashing Machine Company alone does a business of $3,000,000 per annum, and ship largely by lake. Many large manufacturers of wagons, carriages, hardware, furniture, boats, etc., are shippers by lake.

The nearest collection district is Milwaukee, Wis.

The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry $305,828.09.

The arrivals and departures of vessels at this harbor during the past fiscal year, as given by the collector of the port of Milwaukee, were as follows:

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	587	382,790	587	382,790
Sailing vessels	388	49,470	386	47,514
Total	975	432,260	973	430,304

H H 4.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

CONDITION OF WORK JUNE 30, 1888.

The piers of this harbor are in fair condition, except short sections of superstructure built in 1872–'74, which are now rotten and require renewal. Within the shore-line at the north pier 60 feet of superstructure were carried away by storms during the winter of 1885–'86, the removal of which has caused erosion to a damaging extent upon the shore-line of the basin near the pier.

The sand is piled up against the north pier for 900 feet beyond the original shore-line, and great quantities of it are annually blown over the pier into the channel-way from these accretions.

In 1876–'77 this harbor was deepened to 15 feet in depth, but the appropriations made have been continually much less than the engineer's estimates, and consequently insufficient for the maintenance of the piers and channel-depth.

At the close of the last fiscal year the channel-depth had deteriorated to 10½ feet at low water. During the past fiscal year 49 white oak piles were driven along the channel face of the inner section of the south pier, and 7,272 cubic yards of sand excavated from the channel, restoring the depth over a channel-width of 40 feet to 14 feet in depth; but this has again deteriorated, until at the close of the fiscal year June 30, 1888, there is an available channel only 12½ feet in depth.

The channel is in urgent need of dredging.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

These funds are to be used in restoring the harbor to 15 feet available depth of navigation, renewing the superstructure built in 1872–'7[illegible] and to extending the south pier towards completion. The pier extension is not urgent, but $8,000 is imperatively needed to restore the channel to its proper and former depth, and is the least amount that will be effective.

Money statement.

July 1, 1887, amount available	$5,547.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,747.
July 1, 1888, balance available	799.
Amount appropriated by act of August 11, 1888	7,500.
Amount available for fiscal year ending June 30, 1889	8,299.

Amount (estimated) required for completion of existing project.....	$33,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Inquiry was made from this office in relation to the amount of business transacted at Kenosha during the past year. In reply to which it was stated that a committee had been appointed by the Business Men's Club to report upon the same, and that the said committee estimated the total value of the business of the city at $30,000,000. A further request was made of Henry Williams, esq., mayor of the city, asking him if it should be practicable to furnish a statement of some of the principal items of business. In reply to which Mr. Williams states as follows: "I have been in consultation with the leading men of the Business Men's Club, relative to the figures of business and commerce of Kenosha, and they say that while the figures given may appear large, they think that the business of Kenosha warrants the estimate given, and decline to consent to a reduction."

The improvements which are at present being made in the buildings and factories of Kenosha are evidence of its increasing prosperity and trade.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis. Amount of revenue collected at the nearest port of entry, $305,828.09.

The arrivals and departures of vessels at this harbor during the past fiscal year, as given by the collector of the port of Milwaukee, were as follows:

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	74	7,333	73	7,711
Sail-vessels	146	19,880	145	19,905
Total	220	27,213	218	27,616

H H 5.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

CONDITION OF WORK JUNE 30, 1888.

Work at this harbor during the past fiscal year has been executed by the method of hired labor and the purchase of materials in the open market, this method being most economical and advantageous to the United States.

During the fiscal year ending June 30, 1888, 71 linear feet of the south pier has been completed and ballast added to the piers to replace the filling washed out by storms; 257 piles were also purchased for the advancement, without delay, of the south pier as soon as funds are made available by further appropriations.

The reports of Assistant Engineer W. H. Hearding, in local charge of the work, herewith, give all details concerning the annual progress.

The north pier now reaches to the 12-foot curve, as it existed in 1879, but the advance of the fore-shore is very rapid, and the piers will have to be materially increased in length in the near future.

The work is not yet far enough advanced to be of material benefit to the commerce of the place, although it is used to a slight degree for light-draught boats.

The harbor is being created upon an exposed coast, in shallow water, remote from shelter, which makes its construction difficult and expensive.

For the sake of economy the appropriations for this work should at least be made sufficient to complete it to the degree that it may be utilized before the piers are rotten and require renewal above the water-line.

An appropriation of $30,000 will allow the completion of both piers to the 12-foot contour, as it existed in 1879, and sufficient dredging beyond the old shore-line and within the harbor to admit of its use to the extent at present demanded by the interests of the place.

The proposed "interior basin" is to be dredged entirely within the shore-line, now above high-water mark. The above estimate is to dredge that part of the harbor only which lies outside the shore-line of 1879.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

The funds now available are sufficient only for watchman and contingent expenses and maintenance, or to repair possible minor damage from unforeseen causes.

The funds asked for the fiscal year ending June 30, 1890, are to be used in the completion of the piers and in dredging the entrance and a portion of the outer basin, to serve as a harbor during the construction of the inner basin, and in dredging and revetting the passage from the outer to the inner basin.

The prospective commercial importance of the harbor is treated in the Annual Report of the Chief of Engineers for 1882, page 2165.

The object to be attained by the construction of this harbor and the desires of the citizens in reference to it are stated in the Report of the Chief of Engineers for 1880, pages 1940–1947.

At present there is but little transportation to and fro by water, the boats being usually compelled to land at an open pier-head.

Traffic by water is almost confined to the lumber trade. The pier at which boats landed having been rendered useless by partial destruction, vessels of sufficiently light draught have used the incomplete harbor to a limited extent.

Money statement.

July 1, 1887, amount available	$9,318.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,043.31
July 1, 1888, balance available	274.80
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,274.80
Amount (estimated) required for completion of existing project	46,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1888.

SIR: The following report upon the improvement of Waukegan Harbor is respectfully submitted.

Subsequent to the report of June 30, 1887, an extension of the south pier was made of pile-work of 71 feet in length, comprising sections Nos. 12 and 13. These sections were completed during the month of July, and the work of pile-driving was suspended, the total length of the south pier extension in 1887, being 167 feet. During August 62,237 cords of stone were placed in and around the south pier, and 120,933 cords were distributed in the sections of the north pier. The total quantity of stone used to supply the deficiency of that material caused by settlement, both inside and around the outer sides of the north pier, was 241,935 cords. Two hundred and fifty-seven white oak piles have been purchased from the lowest of four competitive bidders, for the extension of the south pier, with the available funds remaining from the appropriation of August 5, 1886, at a cost of 22 cents per linear foot, delivered on the beach in front of the harbor.

The deposit of sand inside the harbor has increased considerably within the past year, and the beach outside the east arm is fully 90 feet in width.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. Army.

COMMERCIAL STATISTICS.

A summary of the business of the city of Waukegan for the past fiscal year is furnished by H. C. Hutchinson, esq., mayor, as follows:

Business of the town		$3,113,000	Lumber, hard-wood	feet, B. M.	750,000
Imports, value		$1,029,000	Wool	pounds	450,000
Exports, value		$818,000	Eggs received	dozen	120,000
Coal received and used	tons	9,990	Freight by railroad	tons	120,000
Tan-bark	cords	570	Freight shipped	do	147,000
Lumber, pine	feet, B. M.	6,875,000	Brick manufactured		6,500,000

The nearest collection district is Chicago, Ill. The nearest port of entry is Chicago, Ill. Amount of revenue collected at the nearest port of entry, $4,850,697.14. Arrivals of vessels, 54; departures, 54.

H H 6.

IMPROVEMENT OF THE FOX AND WISCONSIN RIVERS, WISCONSIN.

During the fiscal year ending June 30, 1888, work on the Fox and Wisconsin rivers, under the river and harbor act of August 5, 1886, has been done as follows:

ON THE WISCONSIN RIVER.

The report of the Board of Engineers for Fortifications and River and Harbor Works, to which the subject of the improvement of the Wisconsin River had been referred by the Engineer Department, was submitted to the Chief of Engineers and to Congress, and published in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

The conclusions of the Board were adverse to the method of improvement by wing-dams, and they recommended that no more work be done on the wing-dams in the bed of the river directed to securing an open-river channel. No work was therefore done on this river, or is contemplated in the future.

ON THE FOX RIVER.

Upper Fox.—The necessary work was done for maintaining the navigation of the river from Portage to Lake Winnebago, including the repairs to locks and dams and the maintenance of existing depth of navigation by dredging.

One hundred and sixty-one thousand seven hundred and forty-seven cubic yards of material was dredged from the bars on the Upper Fox to maintain navigation and minor repairs to mechanical structures were made where needed, as specified in detail in the report of Assistant Engineer C. A. Fuller, hereto appended.

Lower Fox.—The work in progress at the close of the last fiscal year at Neenah and Menasha, in accordance with the recommendations of the Board of Engineers, September 17, 1884, approved by the Secretary of War December 10, 1884, to comply with the provisions attached to the river and harbor acts of August 2, 1882, and July 5, 1884, were completed during the past fiscal year.

The dredging to remove the inequalities in the rock-cut in Menasha Channel was completed, and a dredged cut 6.6 feet in depth below the crest of the Menasha Dam, to connect the rock-cut with deep water in Lake Winnebago, began and nearly completed. A dredged cut was made below the Menasha Lock to connect with deep water in Little Lake Buttes des Morts. Bowlders were removed from Grignon Rapids. Kaukauna Fifth Lock and Appleton Third Lock were thoroughly renovated. Extensive repairs were made to Rapid Croche Lock, and new gates built for the combined locks at Little Chute where other repairs were also made. In all 63,148 cubic yards of gravel and sand were dredged from the channels on the Lower Fox, and 601 cords of stone and bowlders removed from the channel. Minor repairs to mechanical constructions and to plant were also made, as specified in detail in the appended report of the superintendent of the works.

Navigation was continued during the season of 1887 until closed by ice November 25, 1887. It was resumed partially April 16, 1888, and wholly June 3, 1888, and maintained to the close of the fiscal year.

Extraordinarily low water again characterized the season; the depth of navigation on the Upper Fox at many places reached to only 2½ feet until the bars could be removed by dredging; boats drawing 5½ feet could run from Green Bay to Appleton during the entire season, but above Appleton, at the Grignon Rapids, and at Menasha, the depth of navigation from July to November did not exceed from 2½ to 3½ feet, due to the mills taking from the pools above the Appleton and Menasha dams water much in excess of the discharge of the Fox River, thus reducing the levels of Lake Winnebago and Little Lake Buttes des Morts below the crest of the dams.

Navigation was practically destroyed at Menasha during most of the season by this practice.

This evil is continually increasing, but a suit has been instituted as a test case by the United States against the water-power companies at Neenah and Menasha to restrain them from drawing down the levels of the pools below the crest of the Menasha Dam. This suit was instituted two years ago, but is contested and still drags; meanwhile navigation, during the greater part of each season, is very seriously injured by these practices of the millers and manufacturers.

All expenditures for the improvement of the Fox River and for new works have been made from the appropriations for the Fox River below Montello, August 5, 1886.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURE DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

The balance of the funds available and on hand will be expended in dredging in the vicinity of the Menasha Canal.

It will be observed that the balance now on hand, and reported in the financial statement herewith, is not all available for work on the Fox River. Of the amount reported, $860.01 is a balance remaining over from an appropriation of $25,000 made in the special act of March 3, 1875, "to aid in the improvement of the Fox and Wisconsin rivers, in the State of Wisconsin," and applicable only to acquiring lands for sites, and to pay expenses relating to flowage of lands, etc.

Ten thousand dollars appropriated by the river and harbor act approved July 5, 1884, to be used for "maintaining the channel between De Pere and Green Bay," and $6,000 "or so much thereof as may be necessary," etc., appropriated by the river and harbor act approved August 5, 1888, for a levee at Portage "to prevent overflow of the Wisconsin River into the Upper Fox River, so as to prevent injury to the Government works on the Fox River," in all $16,860.01, is not available for the purpose of improving Fox River.

Of these amounts the first named is used principally for the legal expenses connected with defending the suits for flowage damages against the United States now in the courts of Wisconsin.

The second is retained until needed to restore the channel between Green Bay and De Pere whenever it will have deteriorated, and the third amount is withheld because a levee at Portage has never yet appeared necessary "to prevent injury to the Government works on the Fox River."

The recommendation made in the last Annual Report of the Chief of Engineers with reference to the two last-mentioned sums is repeated, *i. e.*, that the terms of the acts may be changed so that these sums may be expended either in the general improvement of the Fox River, or for the purposes evidently intended.

A levee is necessary at Portage for the protection of the interests of the Fox River Valley, and a deeper channel than has existed is necessary for commerce between De Pere and Green Bay.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

The estimate herewith submitted is for continuing the work under the project contained in the report of the Board of Engineers, dated September 17, 1884, approved by the Secretary of War December 10, 1884 (see Report of the Chief of Engineers, U. S. Army, for 1885, pages 2041 to 2046, inclusive), as further modified by authority of the Chief of Engineers, upon the recommendation of the Board of Engineers for Fortifications and for River and Harbor Improvements, May 14, 1886, which project as modified contemplates the rebuilding of the Cedars Lock, the renovation of the old locks as they require it, and the deepening and widening the channel of the Fox River throughout to 6 feet depth and 100 feet width, without reference to the original project.

This forms part of the original project, the object of which was to secure a cheap route of transportation from the Mississippi River to the Great Lakes and Atlantic sea-board, the advantages of which are set forth in numerous reports, and especially in the report of Maj. C. K. Warren, Corps of Engineers, in the Report of the Chief of Engineers for 1868, page 357, and in the report of the Select Committee on Transportation Routes to the Sea-board, United States Senate, 1874.

The present status of this project may be seen from the report of the Board of Engineers, contained in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

It is proposed to apply funds given by Congress to first improve the navigation of the river by deepening and widening the channels throughout, by rock excavation and dredging, to the full capacity of the existing locks, in order that the full benefit of the locks already built will be attained and remain available.

This river has its effect upon rates on all freight carried to points in the Fox River Valley, which is the most thickly settled portion of the interior of Wisconsin and an important manufacturing region; all freights during the season of navigation, and particularly heavy freights, are reduced to near the price of water carriage, whether carried by boat or by the competing railroads, and for the reason that it is a regulator of freights it is of such value that the works should be maintained and the navigation improved at least to the extent contemplated by the modified project of 1884.

The water users, however, must be restrained and prevented from continuing their encroachments upon the right of the public to the benefit of the improved navigation of the Fox River, otherwise all past expenditures are rendered valueless and future expenditures by the United States folly.

Money statement.

July 1, 1887, amount available	$44,300.28
Fuel sold to officers, deposited to the credit of appropriation	175.00
	44,475.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24,535.67
July 1, 1888, balance available	19,939.61
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	119,939.61

Amount (estimated) required for completion of existing project, Fox River	445,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

FOX RIVER—REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Appleton, Wis., July 1, 1888.

CAPTAIN: I have the honor to submit the following report of operations on the improvement of the Fox River, Wisconsin, from Portage to Green Bay, for the fiscal year ending June 30, 1888:

Operations during the year were confined principally to renovating the old Kaukauna Fifth and Appleton Third locks; to completing the widening and deepening the Neenah outlet of Lake Winnebago by dredging; to removing the blasted material from the rock-cut in the channel of the Menasha River, and to dredging a direct channel from Lake Winnebago to the head of the rock-cut; to deepening the channel of the river by dredging; to making repairs of boats and dredges and incidental repairs of locks, dams, and canal banks.

Navigation was continued until closed by ice on the 25th of November. It was partially resumed on the 16th of April, and wholly so on the 3d of June, and maintained to the present date.

Boats drawing not exceeding 5½ feet of water could run during the whole season of navigation between Green Bay and Appleton. From Appleton to Lake Winnebago, owing to the mills drawing off water from the lake, navigation as early as the latter part of July became difficult, except for very light draught boats, and in August they could carry but little freight, and one boat was withdrawn from that part of the river. From that time to November the water was continuously lowered by the

ills, so that at that date the level of the lake was 2.60 feet below the crest of the enasha Dam.

During the low-water season there was but 2½ feet of water on some of the bars in ie Upper Fox.

The following outline of operations at each point between Portage and Green Bay, nder separate heads, viz, "Operating and care of canals and other works of navi-ation" and "Improving Fox River," is respectfully submitted.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION.

De Pere Lock.—A leak through the bank between the lock and the head of the canal as filled in with clay and puddled.

Little Kaukauna Lock.—Two new diamond blocks were framed, placed, and bolted.

Rapid Croche Canal Bank.—Three hundred and fifty feet in length of the left bank bove the head of the lock was raised and strengthened, and the right bank near ie lock was raised.

Rapid Croche Dam.—A washout in rear of the left abutment was filled with clay, nd rubble-stone piled in, to prevent further washing.

Rapid Croche Lock.—Ice was cut away from the gates and an examination made of ie platform and miter-sills. A coffer-dam of clay, 14 feet high and 10 feet wide on ip, was built across the canal above the lock by Dredge No. 1. A coffer-dam below ie lock was built of cribs and horses, planked and backed with clay. Owing to icessive high water, it was found necessary to connect this coffer-dam with the lock y banks 140 feet long. Eight hundred and ninety cubic yards of clay were put in iese banks, and 60 linear feet of double sheet-piling were placed and secured. The ump and engine were set and the water pumped out.

The leak under the upper platform was stopped and the platform and recesses were ewly planked. The gates were repaired and the valve rods shortened and reset. 'wo new check-pieces were framed, placed, and bolted in the lower miter-sill and he miter sill rebolted. The floor of the lock was spiked down and a few broken lanks were removed and replaced by new ones. The capstan platforms and hand-ails were repaired, the lock cleaned out, and the pump and engine removed.

The coffer-dams were taken out by Dredge No. 2, and the lock was open for naviga-ion on the 2d of June.

There were purchased and expended 24,367 feet, B. M., of pine lumber, 364 linear et of oak stringers, 1,080 pounds of iron, and 180 cubic yards of clay.

Kaukauna Fifth Lock.—A low coffer-dam was built across the canal above the lock, nd one 14 feet high, 10 feet wide, on top, and 120 feet long was put in by Dredge No. The pump and engine were placed. A pit was blasted in rock to lower the pump nd the lock was pumped out. The planks were stripped from the walls and the ping timbers, posts, and girts removed. Six hundred and eighty-seven linear feet girts and 207 of posts were framed and placed; 7,248 superficial feet of double pine lanking was placed and spiked, and new coping timbers throughout were framed nd secured. A new lower hollow quoin was put in, bolted, and backed with cement iasonry. Sixteen holes were drilled and reamed, and the upper miter sill placed nd secured with wedge-bolts. Twelve anchor-bolts were placed in the chamber-alls and a stone filling put in between the top coping timbers. The upper gates ere taken apart, new heel-and-toe posts and 20 arms were framed and placed, the ons refitted, and the gates hung. The lower miter-sill was rebolted; 4 capstan plat-rms were framed and planked; 3 old diamond blocks were repaired and one new ne framed, placed, and secured; 5 snubbing-posts were framed, placed, and braced. he lower end of the left lower wing-wall was relaid and steps placed, completing ie repairs. The pump and engine were removed and the lock cleaned out. The ffer-dams were taken out by Dredge No. 1, and the dredge moved to Rapid Croche. uring the progress of the work large quantities of ice and snow were removed from ie lock.

There were purchased and expended 41,616 feet, B. M., of pine plank; 13,182 feet, B. ., of pine timber; 40,472 feet, B. M., of oak timber; 2,000 pounds of spikes; 65 car-ige bolts and washers, and 6 barrels of cement.

Kaukauna Fourth Lock.—One new capstan platform was built; the left upper gate paired; hand-rails put on, and new chains, lugs, and turnbuckles put on the plat-rm valves.

Kaukauna Third Lock.—One snubbing-post was framed and placed; hand-rails ere repaired, and new chains, turnbuckles, and lugs put on the platform valves.

Kaukauna Second Lock.—Two arms were framed and placed in the upper gates; the nd-rails were repaired on all the gates; the valve-rods taken off and shortened, and ight repairs made to gate hangings.

Kaukauna First Lock.—No repairs of this lock were required during the year.

Kaukauna Canal Banks.—During the extreme high-water of April, 1888, a dangerous

break occurred in the levee on the right bank of the river near the dam. A strong force was at once put on, and by working day and night it was closed in forty-eight hours. The levee was raised 1 foot and widened 10 feet. Seven hundred linear feet of the right canal bank from the first lock was raised 1 foot with clay and planks. Leaks in second, third, fourth, and fifth levels were stopped and a washout in the waste-weir near the fifth lock was filled in.

Kaukauna Dam.—The right abutment that was in a dangerous condition was rebuilt. Coffer-dams were put in, pump and engine set, the old abutment partly removed and 14 cords of stone taken out from the end of the dam; 291 lineal feet of pitched face stone were brought from the stone-yard at Kaukauna quarry; 49 cubic yards of cement masonry and 112 cubic yards of dry stone wall were laid; 363 cubic yards of clay and gravel were excavated for the foundations, and 112 cubic yards of clay puddled in rear of the abutment.

Repairs were made to the sluice-way in the dam, which is 75 feet in length, and 2 feet 10 inches below the crest. The water was shut off by flush-boards, the apron removed, and a timber abutment built at each end; three trestles were framed, placed, and secured; the planking around the trestles and abutments relaid, and the trestles and abutments sheathed with 2-inch oak plank. Planks for closing the sluices were fitted; 13-foot walk trestles between the left abutment and the sluice-way were framed, placed, and secured, and the foot-walk laid, completing the repairs.

There were purchased and expended for the sluice-way 680 pounds of drift-bolts, 228 pounds of screw-bolts, 1,005 pounds of round iron, 58 pounds of nails, 2,347 feet, B. M., of oak, and 3,908 of pine lumber.

For the abutment 296 pounds of drift-bolts, 222 feet, B. M., pine plank, 1,890 feet, B. M., of pine lumber, and 4½ cords of wood.

Little Chute Combined Locks.—Timber for four new gates, engine, pump, and tools were loaded on a scow at Appleton and poled to the locks. Ice was removed from the site of the lower coffer-dam and from the valve platform. The middle and lower gates were taken out. The lower and upper coffer-dams were built; two pumps and engines set and the locks pumped out. Cheeks were cut in the coping for gate-hangings; new middle and lower gates were built, ironed, and hung; new cheek pieces for the lower miter-sill were framed, put in, and bolted, and the sill rebolted; thirteen posts were framed and placed under the middle platform; six capstan platforms built; four snubbing posts put in; gate-spars and hand-rails put on, and new chains and lugs put on the platform valves; two diamond-blocks were framed and placed for the upper gates; 200 cubic yards of mud were removed from the lock and the upper one cleaned. The pumps, engines, and tools were removed and the coffer-dams taken out by Dredge No. 2.

Little Chute Canal Banks.—The banks in the second and third levels were raised and strengthened.

There were purchased and expended in repairs of the Little Chute Combined Locks 16,710 feet, B. M., of white oak lumber, 15,536 feet, B. M., of white pine lumber, 1,255 pounds of iron-gate hangings, 407 pounds of round iron, 2 kegs of nails, 340 pounds of three-eighth inch valve-chains, and 2 barrels of cement.

Waste Weir Little Chute, third level.—Portions of the rear wall were relaid in cement, and the canal side repointed.

There were purchased and expended 5 barrels of cement.

Little Chute Dam.—Sink-holes in rear of the left abutment were filled with clay and puddled.

Little Chute Second Lock.—The gate-straps were repaired, new hand-rails and fenders put on, and a leak below the lower wing-wall filled with 26 cubic yards of clay.

Cedars Lock.—Two guiding-cribs to mark the dredged channel below the lock were framed, placed, and filled with stone.

Cedars Dam.—Sink-holes near the left abutment were filled with clay and puddled.

Appleton Lower Dam.—The backing was repaired by putting in a quantity of brush and placing 1,135 cubic yards of clay and gravel.

Appleton Fourth Lock.—The head of the lock and the recess walls were raised with planks, backed with clay during the extreme high water, and the tops of the upper gates planked.

Appleton Canal, fourth level.—The left bank from the dam to the fourth lock was raised 1 foot and strengthened.

Appleton Third Lock.—Coffer-dams were put in by Dredge No. 2. A pit for a centrifugal pump, 2 feet in depth, was excavated in the rock, and a drainage ditch blasted out. A pump and engine were set; the water pumped out and kept so. Ice and snow were removed. Twenty-one cubic yards of clay were removed from the rear of the side walls. The old masonry in the head walls was taken out and the walls rebuilt with 66 cubic yards of cement masonry and backed with 9 cubic yards of clay, puddled. All of the old posts, girts, and planks, except the lower girts, were removed from the walls and replaced by new. Portions of the old stone in the chamber walls were removed, and 1,171 cubic yards of wall laid in their places; 70 anchor-

and washers were put in; the old coping-timbers were removed, new ones framed placed, and the top of the walls between the timbers planked with 3-inch pine k; 28,380 feet, B. M., of double 2-inch pine plank was framed, placed, and spiked e sides; four capstan platforms were rebuilt; two new diamond-blocks for the r gates were placed and the gates hung; six snubbing-posts were put in and ed, and the gate-spars were made and attached; eight automatic valves were and placed in the chamber walls; 240 lineal feet of 8-inch by 10-inch and 10- by 12 inch pine was bolted to the rock bottom near the walls with thirty-six ge-bolts; 46 cubic yards of cement masonry were laid above the upper miter-sill in place of the loose rock excavated near the chamber walls; 46 cubic yards of stone wall was laid along the canal-bank and the waste-weir; 280 cubic yards of were placed in the rear of the walls. The coping at the head of lock was dow- and the head walls pointed, completing the repairs. The lock was cleaned out, the p and engine and tools removed and the coffer-dams taken out by Dredge No. 2. ere were purchased and expended 43,357 feet, B. M., of oak lumber, 57,743 feet, B. of pine lumber, 3,000 feet, B. M., of 2-inch pine plank, 2,400 pounds of wrought- spikes, 6,303 pounds of anchor-rods and washers, 60 carriage-bolts, 105 screw- , 113 barrels of cement, 58 cords of wood, and 30,800 pounds of bituminous coal.

ste Weir, Appleton Canal, third level.—The masonry wall at the head of the weir taken down, relaid in cement, and a new floor put in.

pleton Second Lock.—Slight repairs were made to the walls.

pleton First Lock.—A leak in the embankment near the head of the lock was ed with puddled clay.

pleton Upper Dam.—Two of the sluice-gates that had been damaged by ice were ired.

masha Lock.—Slight repairs were made.

masha Dam.—This dam having settled slightly, the crest timber was removed, a new one of white oak, 10 inches wide and 5 inches thick, was framed, placed, secured by drift-bolts and leveled and planed to the required height.

ere were purchased and expended 1,762 feet, B. M., of oak lumber and 320 pounds ift-bolts.

reka Lock.—One hundred and thirty rods of the fence around the Government erty was repaired. The protection cribs of the gate-hangings that were washed by the high water were replaced and repaired; gate-hangings and hand-rails repaired; 3,895 feet, B. M., of pine boards, 300 cedar posts, and 200 pounds of were purchased and expended on repairs of fence.

rlin Lock.—The old gates from White River Lock were repaired, newly planked, roned. The gates of this lock were taken out and replaced by the repaired ones. snubbing-posts were made and set, and the walls above water, including the g, were repointed.

ring the spring flood the water rose to a height of 2.70 feet above the top of the lock- g and one lower gate was unshipped; the hand-rails and spars of the upper gates broken, and one capstan damaged. The gate was rehung, the capstan repaired, new spars and hand-rails put on.

ur barrels of Portland cement were purchased and expended in repointing the .

ite River Lock.—The old gates taken from Princeton Lock were repaired and d. The White River gates were taken apart, the timbers and iron loaded on a and poled to Berlin Lock. Three capstan platforms, four snubbing-posts, four , hand-rails, and water-gauges were made and placed. Three hundred lineal feet nk between the head of the lock and the levee, that had been partly washed out, repaired.

inceton Lock.—Three sets of capstan timbers and six snubbing-posts were framed placed. Two hundred rods along the bank of the river were raised and strength- .

and River Lock.—No repairs were required.

ntello Lock.—The levee between the lock and the left bank of the river was d and strengthened.

vernor Bend Dam.—Bolts for flush-boards, stone, lumber, etc., were purchased at ge, and with tools were put on scows and transported to the dam. Flush-boards put on, planks from the apron removed, and the hollow space filled with stone rush. Two rows of sheet-piling were driven, the timbers of the apron and crib ted, and the apron recovered with 4-inch plank well spiked. Large bowlders picked up along the shore and dumped below the dam. The scow with tools owed back to Portage Canal by the tug-boat *Dekorra*.

ere were purchased and expended 2,750 feet, B. M., of pine plank, 363 pounds of bolts, 200 pounds of round iron, and 2 kegs of nails.

rtage Lock.—The banks were raised and the lock protected from overflow by high r in the Wisconsin River.

DREDGING.

Dredge No. 1 completed dredging out the cut 100 feet in width below Menasha Lock, removing 25,374 cubic yards of soft material, and then moved down to Gringnon Rapids, above Appleton, and took out bowlders and loose rock from the channel. The dredge was then towed to Kaukauna by the steam-launch *General Meade*, and took out 3,820 cubic yards of mud from the fifth level of the canal, placed it in dump-scows and dumped it into deep water in the river below the fifth lock.

There were purchased and expended 88 cords of wood.

Dredge No. 4.—Worked on the bars in the channel between Berlin and Omro, and removed 84,528 cubic yards of sand. Work was suspended for the season on the 24th of October, when the dredge was towed from Omro to Berlin Lock, laid up, and the crew discharged.

Dredge No. 5.—Worked down from Wilson's Bar, below Grand River Lock, to the bar above White River Lock, removing from the channel 76,219 cubic yards of sand and clay. Work was suspended for the season, the dredge dropped to Berlin Lock, laid up, and the crew discharged.

There were purchased and expended as fuel for Dredges Nos. 4 and 5, and for the tug-boat *Boscobel*, 272 cords of wood and 78,415 pounds of bituminous coal.

REPAIRS OF QUARTER BOAT NO. 1.

This boat was repaired at Berlin Lock and towed to Kaukauna Fifth Lock by the tug-boat *Boscobel* for use of men employed on repairs of that lock.

Old butting-beams were removed and replaced by new ones, decayed beams spliced, 1,800 feet, B. M., of new floor laid, and the roof repaired. New sills were placed under the cabin; rotten planks in the rakes removed and replaced by new, and the rakes and sides calked; three doors and five window-frames were made and placed, three doors hung, and twelve windows reglazed. The boat was painted inside and out, completing the repairs. There were purchased and expended 5,100 feet, B. M., of white pine flooring, 500 pounds of building paper, 1 keg of nails, 238 pounds of white lead, 25 pounds of iron paint, 10 gallons of turpentine, 1 barrel of boiled linseed-oil, six doors and trimmings, and 1 barrel of pitch.

IMPROVING FOX RIVER.

Menasha Channel.—Dredge No. 2 removed 3,791 cubic yards of gravel and 506 cords of blasted material from the rock cut, which was placed on dump-scows, poled to the right bank of the river, wheeled out, and piled upon the bank. The dredge was then moved to the foot of the cut, and removed 3,004 cubic yards of gravel and 81 cords of stone from the old channel between the rock cut and the head of the canal, and then moved to the head of the cut to assist Dredge No. 3 in dredging a direct channel to Lake Winnebago.

Dredge No. 3, after completing the work at the head of the Neenah Outlet, was towed to the Menasha River by the tug-boat *Dekorra*, and after removing from the rock cut small coamings and isolated rocks left by Dredge No. 2, commenced dredging the direct channel to the lake. There were removed 35,392 cubic yards of clay and hard pan, of which 27,700 cubic yards were placed on dump-scows, towed to deep water in the lake by the tug-boat *Dakorra* and dumped, and 7,692 cubic yards placed on a dredge bank on the left side of the channel. The dredging was completed October 30. The width of the channel on the bottom is 100 feet; at the water surface, 115 feet, and its minimum depth is 6.60 feet below the level of the crest of the Menasha Dam. The width of rock cut at bottom is 84 feet, and its depth not less than 6.14 feet below the level of the crest of the Menasha Dam.

Work was suspended on the 31st of October, when Dredge No. 3 was towed to Appleton, by the steam-launch *General Meade*, where she was temporarily laid up and the crew discharged. Dredge No. 3, owing to low water, could not get through the Menasha Canal, and was laid up above the dam and the crew discharged. Work was resumed on the 13th of June by Dredge No. 2, on the Menasha Channel, between the foot of the rock cut and the head of the canal. Two thousand eight hundred and twenty-one cubic yards of gravel and 14 cords of stone were removed, placed on scows, poled to the right bank of the river, and unloaded.

There were purchased and received for use by Dredges Nos. 2 and 3, and the tug-boat *Dekorra*, 215 cords of wood, 23,355 pounds of bituminous coal.

Widening the head of the Neenah Outlet of Lake Winnebago.—Dredge No. 3 removed 1,950 cubic yards of clay, gravel, and hard pan, which was placed on scows, towed to deep water in Lake Winnebago by the tug boat *Dekorra*, and dumped. This work was completed on July 12, and the plant transferred to the Menasha Channel.

REPAIRS OF BOATS AND DREDGES.

Dredge No. 2.—The dipper was removed, taken to Chicago, repaired and returned; the swinging and hoisting engines, crane, turn-table, dipper-handle, and boiler were repaired.

Dredge No. 4.—A new galvanized iron ash-pan was put in; the roof new canvased and painted; the boom and dipper repaired, the hull calked above water, and the machinery set up and put in working order.

Tug-boat Boscobel.—Eighty-five linear feet of new fender strake, and new forward chocks were put on; 3 fenders made and four supports put in; the wheel-houses were replanked; the cabin painted inside and out; the tin roof repaired and the boiler patched; 2 new short couplings were bored; a new ash-pan was put in, and slight repairs were made to the machinery.

There were purchased and expended 260 yards of roofing canvas, and 60 lineal feet of iron pipe.

Steam-launch General Meade.—The boat was hauled out, old planks removed from the bottom, replaced by new, and the hull calked. New guard timbers were put in on sides, the floor was relaid with new plank, and the boat painted. The engine was taken to a machine-shop, repaired and replaced, and the boat launched.

SURVEYS.

A line of levels was run from Menasha to De Pere, and bench-marks were established at all of the locks and dams on the line.

A level line was also run from the crest of the Menasha Dam to that of the dam at Neenah and return.

A survey was made of a portion of the first level of the Kaukauna Canal and plans and estimates made for a retaining-wall along its left bank.

MISCELLANEOUS.

The steam-launch *General Meade* was employed in towing dump-scows for Dredge No. 1, in towing scow loads of materials, tools, etc., for works in progress and in making inspection trips.

The steamer *Henrietta* was laid up at Appleton, Wis., on the 20th of November, 1886, and has not since been put in commission.

Dredge No. 1, while temporarily laid up in Rapid Croche Canal, was burnt and sunk on the night of the 29th of April, 1888, and the watchman on board was burnt up with it. The hull and upper works were entirely destroyed and the machinery so badly injured that but little, if any, of it can be used again. The fire, it is believed, was accidental.

The old crib locks have, as heretofore, required extensive repairs to keep them in working order, and will continue to do so until they are replaced by new ones.

The following work is required to be done to complete this improvement: To replace the old lower dam at Appleton by a new one; to complete the excavation of a 6-foot channel from Lake Winnebago to the head of the Menasha Canal; to lower the bottom of the Menasha Canal 2 feet by dredging; to construct a new dam in place of the old one near Eureka Lock; to deepen the river channel to 6 feet at low water; to strengthen and face the canal banks, and to build dwellings for lock-tenders.

Very respectfully, your obedient servant,

C. A. FULLER,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis. Amount of revenue collected at the nearest port of entry during the fiscal year, $305,828.09.

Total number of lockages in year at De Pere Lock and Eureka Lock, the last lock of system on Lower Fox and Upper Fox, respectively.

Date.	No. of lockages at De Pere Lock, Lower Fox.	No. of lockages at Eureka Lock, Upper Fox.
July, 1887	76	69
August, 1887	106	96
September, 1887	131	41
October, 1887	120	80
November, 1887	59	36
December, 1887	(*)	(*)
January, 1888	(*)	(*)
February, 1888	(*)	(*)
March, 1888	(*)	(*)
April, 1888	29	22
May, 1888	88	63
June, 1888	132	75
Total	741	481

*Closed.

H H 7.

OPERATING AND CARE OF LOCKS AND DAMS ON THE FOX AND WISCONSIN RIVERS, WISCONSIN.

The expense of maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams, and for lock-tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of the river and harbor act approved July 5, 1884.

A detailed statement of the expenditures under this latter appropriation accompanies this report.

Under the indefinite appropriation for the "operating and care of canals and other works of navigation," it is proposed to renew the wooden linings of two of the old timber locks; to maintain the existing depth of navigation in the river and canals by dredging; to keep in general repair locks, dams, and canal banks, and pay for lock-tenders' services and superintendence.

Money statement.

[Operating and care of canals and other works of navigation applied to Fox River, Wisconsin.]

July 1, 1888, amount expended during fiscal year	$52,204.77
July 1, 1888, amount covered by existing contracts	52,204.77
Amount (estimated) for expenditure in fiscal year ending June 30, 1889	48,900.00

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION APPLIED TO FOX AND WISCONSIN RIVERS, WISCONSIN; SECTION 4, RIVER AND HARBOR ACT, JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1888, with itemized statement of expenses attached, as required by the above act of July 5, 1884.

General repairs of locks and dams:		
Labor	$220.58	
Materials, transportation, and supplies	515.94	
		$736.52
Repairs of Rapid Croche Lock:		
Labor and transportation	1,913.70	
Materials	489.22	
		2,402.92
Repairs of canal banks, Rapid Croche:		
Labor		118.67
Repairs of Kaukauna, fifth lock:		
Labor and transportation	3,925.63	
Materials and supplies	2,990.95	
		6,916.58
Repairs of Kaukauna, fourth lock:		
Labor	59.28	
Materials	6.56	
		65.84
Repairs of Kaukauna, third lock:		
Labor		45.33
Repairs of Kaukauna, second lock:		
Labor		78.21
Repairs of Kaukauna Canal banks:		
Labor and transportation	840.50	
Materials	78.35	
		918.85
Repairs of Kaukauna Dam sluiceway:		
Labor and transportation	412.73	
Materials	235.66	
Fuel for steam-launch	17.54	
		665.93
Repairs of right abutment, Kaukauna Dam:		
Labor	1,963.98	
Materials, supplies, and transportation	1,949.70	
		255.72
Repairs of canal banks, Little Chute:		
Labor and transportation	270.00	
Materials	7.50	
		277.50
Repairs of Little Chute Dam:		
Labor		44.34
Repairs of Little Chute Combined Locks:		
Labor and transportation	2,501.66	
Materials and supplies	1,948.66	
		4,450.32
Repairs of Little Chute Second Lock:		
Labor		38.25
Repairs of Cedars Lock and Dam:		
Labor and transportation	284.03	
Materials	108.02	
		392.05
Repairs of canal bank, Appleton, fourth level:		
Labor and transportation		262.23
Repairs of Appleton Fourth Lock:		
Labor		4.00
Repairs of Appleton Third Lock:		
Labor and transportation	5,554.70	
Materials and supplies	3,205.56	
		8,760.26
Repairs of waste-weir, Appleton, third level:		
Labor		29.90

Repairs of Appleton canal banks:		
Labor	$316.22	
Materials	68.10	
		$384.32
Repairs of Appleton Lower Dam:		
Labor	401.20	
Materials	29.13	
		430.33
Repairs of Appleton Upper Dam:		
Labor		21.05
Repairs of Menasha Dam:		
Labor	115.93	
Materials	94.46	
		210.39
Repairs of Menasha Lock:		
Labor	711.97	
Materials	235.80	
		947.77
Dredging bars, Lower Fox:		
Labor	2,210.99	
Fuel, supplies, etc	479,65	
		2,690.64
Dredging bars, Upper Fox:		
Labor	4,372.57	
Fuel, supplies, etc	1,773.73	
		6,146.30
Repairs of locks, Upper Fox:		
Materials		96.07
Repairs of lock gates, Upper Fox:		
Labor	1,216.88	
Materials, transportation, etc	113.76	
		1,330.64
Repairs of Eureka Lock:		
Labor	69.60	
Materials	76.70	
		146.[illegible]
Repairs of Berlin Lock:		
Labor	$55.71	
Materials	17.64	
		73.-
Repairs of White River Lock:		
Labor	110.20	
Materials	5.00	
		115.-
Repairs of Princeton Lock:		
Labor		35.-
Repairs of Montello Lock:		
Labor		36.-
Repairs of Governor Bend Dam:		
Labor and transportation	292.14	
Materials and supplies	151.69	
		443.-
Repairs of Portage Lock and Canal:		
Labor		50.-
Repairs of Quarter Boat No. 1:		
Labor	153.67	
Materials	140.51	
		294.-
Maintenance of navigation:		
Lock-tenders' services	5,240.31	
Gauge-keepers' services	157.99	
Transportation	133.22	
		5,531.-
Care of works and property:		
Watchmen, labor, and transportation	869.64	
Hire of store-house at Appleton	135 00	
Traveling expenses of assistant engineers, overseers, etc	259.10	
Materials	71.55	
		1,335.-

tingencies:

Salaries of assistant engineer, clerks, etc	$3,160.00	
Rent of office, Appleton	125.00	
Rent of office, Milwaukee	210.00	
Mileage of officers	32.00	
Stationery	141.34	
Advertising	59.10	
		$3,727.44
Total		52,204.77

ized statement of expenses made from appropriation for operating and care of canals d other works of navigation, indefinite act of July 5, 1884, applied to Fox River, Wisnsin.

te.	No. of voucher.	To whom paid.	For what paid.	Amount.
7.				
5	1	Alexander Sims	Services	$30.00
5	2	Hired men	Services, June, 1887	3,145.08
13	3	C. A. Fuller	Traveling expenses	17.66
14	4	Mahi Jansen	Services	11.00
18	5	Charles M. Cole	Traveling expenses	7.24
28	6	Des Forges & Co	Stationery	19.45
28	7	G. D. Norris & Co	Rope	127.13
28	8	Barney Gorey	Wood	22.50
28	9	Ferdinand Reitze	do	35.00
28	10	H. Stedman	do	15.40
28	11	Charles S. Morris	Coal and wood	165.55
28	12	Reese & Whiting	Table linen, etc	17.54
28	13	McKenzie & Crawford	Coal	16.10
28	14	A. Sanford Manufacturing Co	Pike-poles, etc	31.33
28	15	James Little & Sons	Bolts, etc	31.18
28	16	McGregor Brothers	Lumber	182.09
28	17	B. T. Gilmore	Rent of office	25.00
28	18	Schlafer, Barrett & Tesch	Rubber hose, etc	56.82
28	19	J. H. Marston & Co	Lime, etc	10.86
28	20	W. F. Montgomery	Oil, etc	29.95
28	21	Morgan & Bassett	Drift-bolts	22.53
28	22	Ramsay & Jones	Lumber	67.58
28	23	J. H. Corcoran	Coal	2.80
28	24	F. Hurlbut	do	2.76
28	25	William Schwager	Wood	107.50
28	26	Reese & Whiting	Soap, lye, etc	6.86
28	27	C. A. Peck	Babbitt metal, etc	42.78
28	28	S. M. Hay & Bro	Lye, etc	16.76
28	29	Drake Brothers	Oil	84.95
28	30	Matthews Bros.' Furniture Co	Mattresses	33.54
28	31	Hoffman & Billings Mfg. Co., Ltd	Packing, etc	11.44
28	32	James Sheriffs	Chain	36.40
28	33	G. D. Norris & Co	Rope, etc	77.12
31	34	C. A. Fuller	Services	200.00
31	35	Andrew O'Connell	do	10.00
31	36	William Edwards	do	35.00
31	37	James Clear	do	35.00
31	38	Richard E. Rice	do	16.00
31	39	John M. Paige	do	35.00
31	40	Friederich A. Thoermer	do	30.00
31	41	Gottlieb Jahnke	do	30.00
31	42	John Lewis	do	30.00
31	43	Jerry Parkinson	do	30.00
31	44	Alexander Sims	do	30.00
31	45	Gabriel Wick	do	30.00
2	1	C. A. Fuller	Traveling expenses	2.21
4	2	Hired men	Services, July, 1887	2,557.05
5	3	N. S. Wight	Lumber	123.16
5	4	Morgan & Bassett	Iron castings, etc	10.68
5	5	Schlafer, Barrett & Tesch	Bolts, rope, etc	10.25
5	6	Ramsay & Jones	Lumber	3.60
5	7	Louis Denis	Lubricator, etc	10.80
5	8	John Strange	Lumber	8.01
5	9	McKenzie & Crawford	Coal and wood	304.88
5	10	Battis Bros	Iron, etc	29.69
5	11	H. S. Sacket	do	14.71
5	12	H. Stedman	Lumber	7.50
5	13	C. A. Peck	Iron, etc	18.81
5	14	Chas. S. Morris	Wood and coal	207.18
5	15	Niels Johnson	Steel, etc	21.51
5	16	Priest & Garrow	Lumber, etc	174.70

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1887.				
Aug. 12	17	John Vandenhuvel	Services	$6.87
13	18	James McLaughlin	do	6.87
13	19	Robert Herman	Traveling expenses	12.29
16	20	William Duescher	Services	9.75
26	21	Henry Vanderloop	do	6.87
31	22	Hired men	do	380.00
31	23	C. A. Fuller	do	200.00
31	24	Andrew O'Connell	do	10.00
31	25	William Edwards	do	35.00
31	26	James Clear	do	35.00
31	27	Richard E. Rice	do	16.00
31	28	John M. Paige	do	35.00
31	29	F. A. Thoermer	do	30.00
31	30	Gottlieb Jahnke	do	30.00
31	31	John Lewis	do	30.00
31	32	Jerry Parkinson	do	30.00
31	33	Alexander Sims	do	30.00
31	34	Gabriel Wick	do	30.00
31	35	George Gifford	do	30.00
Sept. 1	1	C. A. Fuller	Traveling expenses	15.22
1	2	Robert Herman	do	15.02
5	3	Hired men	Services, August, 1887	2,291.74
5	4	Des Forges & Co	Stationery	33.23
5	5	N. S. Wight	Lumber	3.60
5	6	H. A. Foster	Oil	22.88
5	7	John Schlosser	Rope, etc	3.55
5	8	Howard & Jennings	Iron castings, etc	16.63
5	9	J. J. Marshall	Oil	1.28
5	10	C. C. Paige	Steel, etc	3.80
5	11	McKenzie & Crawford	Coal and wood	109.80
5	12	Richard Hackett	Rivets, etc	7.62
5	13	Charles S. Morris	Wood and coal	158.32
5	14	Niels Johnson	Steel, etc	77.27
5	15	H. Stedman	Lumber	18.78
5	16	H. S. Sacket	Iron, etc	12.25
5	17	F. T. Yahr	Wood	68.25
5	18	Llywelyn Breese	Lumber and coal	58.19
5	19	Breese, Loomis & Co	Rubber boots	7.00
5	20	L. D. Comstock	Stone	57.37
5	21	J. E. Wells & Co	Iron and nails	16.80
8	22	Thomas McGee	Services	17.70
12	23	August Rintelman	Traveling expenses	16.50
26	24	C. A. Fuller	do	15.[illegible]
30	25	do	Services	200.[illegible]
30	26	Andrew O'Connell	do	10.[illegible]
30	27	William Edwards	do	35.[illegible]
30	28	James Clear	do	35.[illegible]
30	29	Richard E. Rice	do	16.[illegible]
30	30	John Lewis	do	30.[illegible]
30	31	Jerry Parkinson	do	30.[illegible]
30	32	Gottlieb Jahnke	do	30.[illegible]
30	33	Gabriel Wick	do	30.[illegible]
30	34	George Gifford	do	30.[illegible]
30	35	Alexander Sims	do	30.[illegible]
30	36	Friederich A. Thoermer	do	30.[illegible]
30	37	John M. Paige	do	35.[illegible]
Oct. 1	1	Drake Brothers	Oil, etc	48.[illegible]
1	2	Hoffman & Billings Mfg. Co., Ltd.	Oiler	9.[illegible]
1	3	Des Forges & Co	Stationery	5.[illegible]
1	4	J. C. Mitchell	Lumber, etc	7.[illegible]
1	5	Butler Brothers	Nails, etc	2.[illegible]
1	6	Schlafer, Barrett & Tesch	Iron, etc	61.[illegible]
1	7	Valley Iron Works Mfg. Co	Bolts, etc	17.[illegible]
1	8	Gerry Lumber Company	Lumber	134.[illegible]
1	9	A. L. Smith	Hire of house	45.[illegible]
1	10	B. T. Gilmore	Rent of office	25.[illegible]
1	11	John Strange	Lumber, etc	12.[illegible]
1	12	Jul. Fieweger & Sons	Iron, etc	10.[illegible]
1	13	Webster Manufacturing Co	Bolts, etc	5.[illegible]
1	14	J. C. Koelsch	Lye, etc	2.[illegible]
1	15	Charles S. Morris	Coal and wood	136.[illegible]
1	16	C. A. Peck	Oils, nails, etc	15.[illegible]
1	17	H. Stedman	Lumber	65.[illegible]
1	18	H. S. Sacket	Rope, etc	44.[illegible]
1	19	Niels Johnson	Iron castings, etc	36.[illegible]
1	20	F. T. Yahr	Wood	62.[illegible]
1	21	C. A. Berthelet	Cement	17.[illegible]

emized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1887.				
ct. 3	22	Robert Herman	Traveling expenses	$5.66
3	23	Hired men	Services, September, 1887	2,637.07
1	24	Morgan & Bassett	Bolts, steel, etc	68.44
21	25	Amil Provost	Services	1.25
21	26	Richard Haas	do	11.55
21	27	C. A. Fuller	Traveling expenses	15.52
25	28	do	do	24.62
31	29	do	Services	200.00
31	30	Andrew O'Connell	do	10.00
31	31	William Edwards	do	35.00
31	32	James Clear	do	35.00
31	33	Richard E. Rice	do	16.00
31	34	John Lewis	do	30.00
31	35	Jerry Parkinson	do	30.00
31	36	Gottlieb Jahke	do	30.00
31	37	Gabriel Wick	do	30.00
31	38	George Gifford	do	30.00
31	39	Alexander Sims	do	30.00
31	40	Friederich A. Thoermer	do	30.00
31	41	John M. Paige	do	35.00
ov. 1	1	Burdick & Armitage	Job printing	13.50
3	2	C. A. Berthelet	Cement	17.62
3	3	Butler Brothers	Ax, etc	2.70
3	4	J. C. Mitchell	Lumber	26.46
3	5	John Schlosser	Shovels, etc	10.20
3	6	J. H. Langenberg	Rubber boots	22.50
3	7	Schlafer, Barrett & Tesch	Wheelbarrows, etc	30.29
3	8	Appleton Machine Company	Drift-bolts	6.95
3	9	J. H. Marston & Co	Wood	341.25
3	10	Horace N. Richmond	Clay	7.50
3	11	H. A. Foster	Oil, etc	2.40
3	12	Julius Fieweger & Sons	Iron, etc	4.30
3	13	A. Sanford Manufacturing Co	Pike-poles	21.00
3	14	McKenzie & Crawford	Coal, etc	131.50
3	15	H. Stedman	Lumber	21.00
3	16	Charles S. Morris	Wood and coal	160.27
3	17	H. S. Sackett	Lamp-black, etc	22.56
3	18	Niels Johnson	Iron, etc	49.61
3	19	J. S. Pahl	Wood	87.50
3	20	William Swankee	do	33.60
3	21	Hired men	Services, October, 1887	3,315.53
8	22	Charles M. Cole	Traveling expenses	13.90
25	23	Lieut. Graham D. Fitch	Mileage	16.00
30	24	Cramer, Aikins & Cramer	Rent of office	70.00
30	25	Robert Herman	Services	150.00
30	26	C. A. Fuller	do	200.00
30	27	George Allanson	do	26.83
30	28	William Edwards	do	33.83
30	29	James Clear	do	26.83
30	30	Richard E. Rice	do	12.26
30	31	John Lewis	do	23.00
30	32	Jerry Parkinson	do	23.00
30	33	Gottlieb Jahnke	do	23.00
30	34	Gabriel Wick	do	23.00
30	35	George Gifford	do	23.00
30	36	Alexander Sims	do	23.00
30	37	Friedrich A. Thoermer	do	23.00
30	38	John M. Paige	do	26.83
30	39	John A. Banker	do	30.00
30	40	Maurice Phillips	do	5.25
ec. 1	1	Andrew O'Connell	do	10.00
2	2	Milwaukee Cement Co	Cement	60.73
2	3	Des Forges & Co	Stationery	18.68
2	4	Henry Collette	Lumber	32.99
2	5	Butler Brothers	Nails, etc	5.59
2	6	Atlas Iron and Brass Works	Iron, etc	2.60
2	7	H. A. Foster	Oil, etc	3.12
2	8	Schlafer, Barrett & Tesch	Rubber belting, etc	26.63
2	9	J. H. Marston & Co	Wood	70.68
2	10	Morgan & Bassett	Iron castings, etc	194.17
2	11	J. F. Joslyn	Drift bolts, etc	11.65
2	12	John Strange	Lumber	54.81
2	13	McKenzie & Crawford	Coal, etc	174.97
2	14	Charles S. Morris	Wood	32.50
2	15	C. A. Fuller	Traveling expenses	9.36
2	16	Samuel Whitney	do	5.25
3	17	E. W. Viall & Co	Advertising	10.20
3	18	Austin L. Patterson	do	22.50

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1887.				
Dec. 3	19	Robinson & Co	Advertising	$4.50
5	20	Hired men	Services, November, 1887	2,325.50
12	21	C. A. Fuller	Traveling expenses	15.54
12	22	The Sentinel Company	Advertising	8.40
20	23	David Smerline	Services	31.05
23	24	James Mackin	do	34.35
31	25	C. A. Fuller	do	200.00
31	26	William Edwards	do	30.00
31	27	John A. Banker	do	30.00
1888.				
Jan. 3	1	C. A. Fuller	Traveling expenses	1.40
4	2	Butler Brothers	Oil, etc	14.07
4	3	Schlafer, Barrett, and Tesch	Rubber belting, etc	37.50
4	4	H. A. Foster	Oil, etc	8.74
4	5	J. H. Langenberg	Rubber boots	11.25
4	6	Fred E. Harriman	Pipe, etc	3.58
4	7	J. H. Marston & Co	Wood	71.50
4	8	Morgan & Bassett	Iron castings, etc	23.40
4	9	B. T. Gilmore	Rent of office	25.00
4	10	A. L. Smith	Hire of house	45.00
4	11	A. Sanford Manufacturing Company.	Peavy stocks	6.80
4	12	Alexander Sims	Services	20.25
4	13	Hired men	Services, December, 1887	2,086.06
4	14	Ramsay & Jones	Lumber	16.20
16	15	James Brown	Services	.87
17	16	Hoffman & Billings Manufacturing Company (limited).	Valve	12.30
31	17	C. A. Fuller	Services	200.00
31	18	William Edwards	do	30.00
31	19	John A. Banker	do	30.00
Feb. 2	1	Des Forges & Co	Stationery	23.50
2	2	C. A. Berthelet	Cement	10.32
2	3	Henry Collette	Lumber	14.00
2	4	Butler Brothers	Bolts, etc	7.84
2	5	J. H. Marston & Co	Wood	28.00
2	6	Appleton Machine Company	Iron bolts, etc	112.62
2	7	Fred E. Harriman	Globe valves, etc	3.40
2	8	John Schlosser	Spikes, etc	177.29
2	9	H. A. Foster	Oil, etc	4.42
2	10	Schlafer, Barrett & Tesch	Shovels, etc	5.95
2	11	McKenzie & Crawford	Coal	10.93
2	12	C. A. Fuller	Traveling expenses	1.15
3	13	Hired men	Services, January 1888	2,072.94
20	14	Capt. W. L. Marshall	Mileage	16.00
20	15	Glenwood Manufacturing Co	Timber	164.15
29	16	Cramer, Aikens & Cramer	Rent of office	70.00
29	17	C. A. Fuller	Services	200.00
29	18	William Edwards	do	30.00
29	19	John A. Banker	do	30.00
Mar. 1	1	C. A. Fuller	Traveling expenses	3.06
2	2	J. H. Marston & Co	Wood	30.87
2	3	Appleton Machine Company	Iron rods, etc	94.47
2	4	H. A. Foster	Oil	3.60
2	5	Schlafer, Barrett & Tesch	Axes, etc	2.72
2	6	John Schlosser	Bolts, etc	5.95
2	7	Henry Collette	Lumber	7.56
2	8	Luther Lindauer	Sand, etc	7.75
2	9	Butler Brothers	Oil, etc	7.52
2	10	McKenzie & Crawford	Coal	39.64
3	11	Hired men	Services, February, 1888	2,253.32
12	12	Louis Beyer	Services	16.20
15	13	N. S. Wight	Timber	3,326.52
31	14	C. A. Fuller	Services	200.00
31	15	Cramer, Aikens & Cramer	Rent of offices	70.00
31	16	William Edwards	Services	30.00
31	17	John A. Banker	do	30.00
Apr. 4	1	Hired men	Services, March, 1888	1,936.23
4	2	J. H. Corcoran	Services	16.80
4	3	C. A. Fuller	Traveling expenses	10.62
4	4	J. C. Mitchell	Lumber	47.52
4	5	Henry Collette	do	5.40
4	6	Butler Brothers	Oil, etc	3.00
4	7	A. L. Smith	Hire of house	45.00
4	8	B. T. Gillmore	Rent of office	25.00
4	9	Schlafer, Barrett & Tesch	Nails	15.75
4	10	H. A. Foster	Oil, etc	2.15

emized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1888.				
pr. 4	11	C. A. Berthelet	Cement	$88.00
4	12	Des Forges & Co	Stationery	24.15
10	13	Gerry Lumber Company	Lumber	1,419.30
19	14	Glenwood Manufacturing Co	Timber	543.50
30	15	C. A. Fuller	Services	200.00
30	16	John M. Paige	do	11.66
May 1	1	Andrew O'Connell	do	4.66
1	2	Alexander Sims	do	10.00
2	3	Bailey Grover	Traveling expenses	6.00
2	4	C. A. Fuller	do	13.22
2	5	Des Forges & Co	Stationery	22.10
2	6	Louis Clairmont	Transportation	44.62
2	7	Butler Brothers	Oil, etc	7.17
2	8	Peter Shafer	Wood	45.24
2	9	J. H. Marston & Co	Wood, etc	92.15
2	10	Morgan & Bassett	Iron castings, etc	6.24
2	11	Gerry Lumber Company	Lumber	461.57
2	12	Schlafer, Barrett & Tesch	Iron, etc	71.74
2	13	H. A. Foster	Oil, etc	4.72
2	14	Battis Brothers	Labor	3.40
2	15	McKenzie & Crawford	Coal	5.67
2	16	F. T. Yahr	Wheelbarrows, etc	7.95
5	17	David Messing	Services	10.50
9	18	Louis Reichel	do	8.25
4	19	Hired men	Services, April, 1888	3,116.09
12	20	Andreas Girisch	Services	7.50
12	21	John Lawrence	do	9.30
12	22	Alfred Remington	do	1.50
12	23	August Spinker	do	4.20
15	24	C. A. Fuller	Traveling expenses	7.90
31	25	C. A. Fuller	Services	200.00
31	26	James Clear	do	35.00
31	27	John A. Banker	do	30.00
31	28	William Edwards	do	35.00
31	29	Richard E. Rice	do	16.00
31	30	John Lewis	do	30.00
31	31	Jerry Parkinson	do	30.00
31	32	Gottlieb Jahnke	do	30.00
31	33	Gabriel Wick	do	30.00
31	34	George Gifford	do	30.00
31	35	Alexander Sims	do	30.00
31	36	John M. Paige	do	35.00
31	37	Andrew O'Connell	do	10.00
31	38	William Crovall	do	6.00
une 2	1	E. N. Neff	Traveling expenses	2.68
2	2	C. A. Fuller	do	13.33
4	3	Hired men	Services, May, 1888	2,962.30
7	4	Shadbolt & Boyd Iron Company	Chain	15.81
7	5	Butler Brothers	Wheelbarrows etc	35.60
7	6	J. C. Mitchell	Lumber	42.75
7	7	George Willems	Wood	32.50
7	8	Gerry Lumber Company	Lumber	36.34
7	9	Ramsey & Jones	do	83.92
7	10	Appleton Machine Company	Iron, etc	3.25
7	11	J. H. Marston & Co	Cement	10.50
7	12	Schlafer, Barrett & Tesch	Iron, etc	13.25
7	13	Charles S. Morris	Coal	9.77
7	14	C. H. Britton	Oil, etc	4.70
7	15	H. Stedman	Coal	16.70
7	16	John Schwark	Hay	5.00
8	17	Charles M. Cole	Traveling expenses	4.94
9	18	Hired men	Services	70.35
7	19	Elias Thomas	do	27.00
18	20	Maurice Graham	do	1.50
19	21	J. H. Corcoran	do	26.60
21	22	Morgan & Bassett	Iron forgings, etc	627.65
22	23	August Johnson	Services	2.25
29	24	Effie Cogan	do	54.60
30	25	C. A. Fuller	do	200.00
30	26	James Clear	do	35.00
30	27	William Edwards	do	35.00
30	28	Richard E. Rice	do	16.00
30	29	John Lewis	do	30.00
30	30	Jerry Parkinson	do	30.00
30	31	Gottlieb Jahnke	do	30.00
30	32	Gabriel Wick	do	30.00
30	33	John A. Banker	do	30.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1888.				
June 30	34	George Gifford	Services	$30.00
30	35	John M. Paige	do	35.00
30	36	John Baeten	do	28.00
30	37	Andrew O'Connell	do	10.00
30	38	Alexander Sims	do	30.00
30	39	Louis Clairmont	Clay	63.35
30	40	Butler Brothers	Chain, etc	15.11
30	41	Appleton Machine Company	Drift-bolts	12.42
30	42	Gerry Lumber Company	Lumber	50.84
30	43	Richmond Brothers	Clay	25.00
30	44	B. T. Gilmore	Rent of office	25.00
30	45	Hired men	Services	380.00
30	46	Des Forges & Co	Stationery	13.05
30	47	C. A. Fuller	Traveling expenses	10.96
30	48	Hired men	Services	636.34
		Total		52,204.77

H H 8.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

The present project was adopted in 1870 and modified in 1878, and contemplates—

a. The formation of an outer harbor or basin, by inclosing a portion of Lake Michigan just south of and adjoining the entrance to the river, for the purpose of increasing the harbor facilities of Chicago, and to give relief to the over-crowded river.

b. The construction of an exterior breakwater of crib-work filled with stone, outside of the outer harbor, in deep water, to shelter the entrance to Chicago River and outer harbor from northerly storms, and to form a sheltered area or harbor of refuge at the southern end of Lake Michigan.

The addition to this incomplete project, the entrance to Chicago River, which is protected by piers built by the United States, is to be maintained, both piers and channel.

CONDITION OF THE WORK JUNE 30, 1888.

Outer harbor.—This basin, south and east of the present mouth of Chicago River, covers about 455 acres in area. A dock and wharf-line were established by special order, Corps of Engineers, No. 108, August 3, 18[illegible] at about 1,300 feet east of the shore-line, and parallel to, and about 2,000 feet west of, the breakwater that limits the basin to the eastward. Between the dock line and breakwater an area of 270 acres is included, which the original project contemplated dredging to 16 feet in depth, where deficient in depth. The area between dock line and shore is reserved for docks and slips. Two hundred and sixty-seven thousand cubic yards of material is yet to be dredged from the outer basin beyond the dock line, but as this material will be valuable for filling shores if the outer basin be used for wharves and docks, and inasmuch as the area already dredged is adequate for present needs, a completion of the work of dredging at this time is not advisable or necessary.

The piers inclosing this harbor have been completed for years, but a portion of the southerly breakwater was damaged by storm December

4, 1885, and requires reconstruction. This gap has not enlarged since the damage was done, and is practically of little importance, but is unsightly.

The superstructures of the north pier and easterly breakwater of the outer basin are rotten and now urgently require rebuilding over an extent of 4,738 linear feet. They should be rebuilt in a permanent manner at the earliest practicable moment.

During the fiscal year ending June 30, 1888, a section of experimental permanent superstructure 95 feet in length was built after the project submitted to the Chief of Engineers by Maj. Thomas H. Handbury, Corps of Engineers, February 9, 1887. This superstructure of artificial stone or concrete of Portland cement in large blocks, backed by concrete of domestic cement, seems to answer well the requirements of a permanent superstructure at this point, and the estimate submitted herewith is based upon the probable cost of such work.

Exterior breakwater.—This structure is 1 mile northeast of the mouth of Chicago River, the entrance to which it covers from northerly storms. It is to be 5,436 feet in length. At the close of the fiscal year ending June 30, 1888, there remains 1,200 linear feet of breakwater to be constructed. Also some work in leveling up the superstructure on cribs that have settled.

During the past fiscal year superstructure over 400 linear feet of substructure, placed prior to June 30, 1887, was constructed. No other work was done for lack of funds.

This breakwater answers the purpose for which it was constructed, and its value as a harbor of refuge and as an aid to navigation is conceded by all persons interested in lake commerce.

Entrance to Chicago River.—The depth of water between the United States piers at the mouth of Chicago River has been diminished by the influx of sand until, at the close of the present fiscal year, there is an available channel-way of less than 15 feet at mean lake-level. At one place midway the entrance there is but 11.8 feet of water. It is needless to say that at a port where the arrivals and departures of vessels aggregate each year over 20,000, where the commerce of the port exceeds that of the largest of our sea-ports, and where the United States collects from customs $5,000,000 annually, that such a condition should not be allowed to exist, and that some provision for maintaining these channels should be made. The development of temporary superstructures and work at Chicago is now so great that the annual appropriations bid fair from now on to be hardly adequate to carry the work projected to completion and to maintain also that already done. The estimate herewith submitted contemplates the completion of the present project and for the present necessities of maintenance of the work already executed.

PROPOSED APPLICATION OF FUNDS AVAILABLE JUNE 30, 1888, AND OF THOSE ASKED FOR FISCAL YEAR ENDING JUNE 30, 1890.

The funds now available will be used in lighting the unfinished exterior breakwater, in guarding and maintaining the plant, and in maintaining the office. The funds asked for the fiscal year ending June 30, 1890, are—

For superstructure over easterly breakwater, outer harbor	$120,000
Completing exterior breakwater and outer basin	240,000
Dredging entrance to Chicago Harbor	12,000
Total	372,000

[illegible]itted in compliance with requiremen[illegible]
harbor acts of 1866 and 1867.

COMMERCIAL ST[illegible]

The nearest collection district is Chicago, Il[illegible]
Ill. Amount of revenue collected at the near[illegible]
year, $4,850.697.14.

Port of Chicago.

Vessels arrived .....
Vessels cleared .....

H H 9.

IMPROVEMENT OF CALUMET R[illegible]

The object of this work is to provide [illegible]
River and the port of South Chicago. [illegible]
manner, by dredging a channel and prot[illegible]
parallel piers, 300 feet apart, projecting [illegible]
mouth.

CONDITION OF WORK JU[illegible]

Work was begun on this harbor in 1870
year June 30, 1888, 3,640 linear feet of th[illegible]
the south pier had been completed, makin[illegible]
of 5,510 linear feet.

There remains to be built, in [illegible]
project, 150 feet in le[illegible]

admit vessels to coal-docks and lumber-yards; but there is still necessary, to give a channel 16 feet deep and 150 feet wide over the area included by the United States piers, some 38,000 cubic yards of dredging, or twice this amount for the full channel width of 300 feet, at an estimated cost of $21,000.

The superstructure over portions of the north and south piers are decayed and need rebuilding for a length of 800 linear feet each, at an estimated cost of $22,500.

The estimate submitted herewith is for completion of the existing project and for the work of maintenance described above.

During the past fiscal year no work of construction has been done, there being no sufficient funds available.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

It is proposed to apply these funds in completing the present approved project in dredging, in filling the piers with stone, and in rebuilding superstructure over 800 linear feet of each pier.

Money statement.

July 1, 1887, amount available	$871.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	93.88
July 1, 1888, balance available	777.70
Amount appropriated by act of August 11, 1888	20,400.00
Amount available for fiscal year ending June 30, 1889	21,177.70
Amount (estimated) required for completion of existing project, and for maintenance	43,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	43,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The harbor of Calumet is at South Chicago, in the collection district of Chicago.

There is a light-house and a keeper's dwelling on the Government reservation, near the shore end of the north pier. A beacon light is maintained at the extremity of the north pier to mark the entrance to the harbor.

Amount of revenue collected at the nearest port of entry (Chicago) during the last fiscal year, $4,850,697.14.

Calumet Harbor.	Number.	Tons.
Vessels arrived	518	352,545
Vessels cleared	493	324,422

H H 10.

IMPROVEMENT OF THE ILLINOIS RIVER, ILLINOIS.

The ultimate object of this improvement is to furnish a thorough route of transportation from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for its navigation by large-sized Mississippi River steam-boats.

The locks are 350 feet in length, 75 feet width, and with 7 feet depth over the miter sills at low water.

The project now being executed is for the improvement of the lower section of this route, viz, from the mouth of Copperas Creek to the Mississippi River, a distance of 135 miles; another section of this route, 88 miles in length, from the mouth of Copperas Creek to La Salle, has been improved by the State of Illinois by the construction of two locks and dams at Copperas Creek and Henry, respectively.

Over this section the State still collects tolls, the United States not having as yet accepted the work under the conditions imposed by the act of the State legislature approved May 31, 1887.

Surveys and estimates for carrying the improvement over a third section, 64 miles in length, from La Salle to Joliet, over which the fall in the water-surface is 100 feet, have been made and submitted to Congress, and may be found in the Annual Report of the Chief of Engineers, U. S. Army, for 1884, page 1958.

The location of the improvement over the fourth section, across the Chicago divide, 39 to 40 miles in length, has not as yet been definitely determined, further surveys being necessary, which have not been authorized by Congress.

The present project involves the construction of two locks and dams, one at La Grange, 75 miles above the mouth of the Illinois, the other at Kampsville, about 30 miles above its mouth, and dredging the channel to 7 feet; more than 2,000,000 cubic yards of dredging, mainly below Kampsville, being required.

CONDITION OF THE WORK JUNE 30, 1888.

At the close of the fiscal year the lock at La Grange was practically completed, the gates are in place, and the filling valves and maneuvering gear placed or on hand; the dam is still to be built, and minor work of earth filling, etc., to be done.

At Kampsville 2,881 cubic yards of cut stone is on hand, and the coffer-dam and the foundation constructed; no masonry has yet been laid; the dam also is still to be built.

But little of the dredging has been done beyond the removal of some of the worst bars to a depth of 4 feet at low water.

During the fiscal year ending June 30, 1888, the following work has been done:

(*a*) *At La Grange Lock.*—The lock was cleaned out, and the floor planked over with 2-inch pine plank, the lower miter-sill was placed and secured, the lower tail-bay mattressed and ballasted, part of the filling behind the lock-wall placed; the gates, valves, maneuvering gear, and snubbing posts placed.

(*b*) *At Kampsville Lock.*—Two thousand eight hundred and eighty-one cubic yards of cut stone were delivered and piled.

(*c*) *Dredging in the channel.*—Twenty-six thousand and sixty-one cubic yards of material were dredged and removed from the channel through bars, where the greatest obstructions to navigation were found.

The plant and appliances were kept in repair, and 121 snags removed from the channel. For details of this work see the accompanying report of Mr. G. B. Hegardt, assistant engineer.

PROPOSED APPLICATION OF FUNDS ON HAND JUNE 30, 1888.

It is proposed to apply the funds now on hand to repairing the pile-drivers and dredges, to excavating the channel below La Grange Lock

tail-bay, to filling in behind the lock-walls, and to guarding the property pertaining to the work.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

It is proposed to apply these funds to complete the La Grange Dam and to open the La Grange Lock to navigation, and to forward towards completion the Kampsville Lock and Dam.

This route from Lake Michigan, near Chicago, to the Mississippi River, via the Illinois, is the most favorable route that exists for a water route of liberal capacity and at moderate cost between the Mississippi Valley and the Great Lakes. The expenditure of an estimated amount of $587,500 will carry a channel 7 feet deep at low water from the mouth to La Salle, 100 miles from Lake Michigan, or, in connection with the work already done by the State of Illinois, will complete 223 miles of the proposed route. A further expenditure of an estimated sum of $3,500,000 will carry the improvement to Joliet, within less than 40 miles of Lake Michigan, at Chicago. To determine the most practicable and available route from this point to the lake, further surveys and investigations are required, for which Congress has not as yet furnished the necessary means.

Since the advantages of this route have been repeatedly brought to the attention of Congress during the past seventy years or more, further discussions here would be merely repetition, and attention will only be invited to the following-named reports heretofore submitted to Congress, within the past twenty years:

General J. H. Wilson, 1867, House Ex. Doc. No. 16, Fortieth Congress, first session.

Colonel Macomb, Corps of Engineers, Report of the Chief of Engineers for 1875; Vol. II, page 525.

Maj. G. J. Lydecker, Reports of the Chief of Engineers, 1879, page 1572; 1880, page 1995.

Maj. W. H. H. Benyaurd, Report of the Chief of Engineers, 1884, page 1958.

Maj. Thomas H. Handbury, Report of the Chief of Engineers, 1887, page 2119.

Report of the Board of Engineers on Hennepin Canal, 1887, Report of the Chief of Engineers, 1887, page 2125.

Money statement

July 1, 1887, amount available	$41,735.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	31,508.03
July 1, 1888, balance available	10,227.35
Amount appropriated by act of August 11, 1888	200,000.00
Amount available for fiscal year ending June 30, 1889	210,227.35

Amount (estimated) required for completion of existing project	387,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	387,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. G. B. HEGARDT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
La Grange Lock, Ill., July 1, 1888.

SIR: I have the honor to submit the following report of operations on the improvement of Illinois River, Illinois, for the fiscal year ending June 30, 1888:

LA GRANGE LOCK.

During the latter part of July pumping engines and pumps were placed in position and gotten ready to commence the pumping out and the draining of the lock-pit during the construction of the lock-gates, head bay platform, laying of lock floor, and paving of tail-bay.

The pumps were started August 4, and the water inside of the coffer-dam lowered to the deposit of sediment on the foundation in a few days.

This sediment had accumulated during four seasons of high water, or since the foundation was completed, and was estimated, from soundings taken, to be 7,200 cubic yards. Five thousand two hundred cubic yards of this was removed from the lock-chamber with pumps during March, April, May, and part of June, 1887. The remaining amount, about 1,900 cubic yards, was taken from the lock-chamber to the top of the bank by dump-cars hauled out with pile-driver.

The sediment having all been removed, the foundation was floored over with 2-inch pine plank.

The lower miter-sill wall was set and secured to the concrete by dowel bolts. The mitre-sill timbers are held down by fourteen 1¼-inch rods, fastened to 12-inch by 12-inch timbers placed longitudinally under the mass of concrete, 6 feet thick, which underlies the whole lower miter-sill wall.

Timbers, 20 inch by 20 inch, extending across the chamber, were bolted to the foundation 10 feet below the lower miter-sill wall on line with the upper side of the stop-gate recesses, and will serve as a heel for a coffer-dam, should it at any time be necessary to pump out the lock for repairs. The space between these timbers and the lower miter sill wall was filled with concrete and covered with 2-inch plank.

In the breast wall and upper miter-sill wall 1¼-inch dowel bolts were put in, from 24 to 40 inches long.

The timbers in the upper miter-sill wall are held down by sixteen rods fastened by fox keys or wedged at their lower ends to the pier-stones of the arches. The rods vary from 1¼ to 1¾ inches in diameter, and 7½ to 5 feet in length.

Checks were cut in the walls at the hollow quoins to receive the iron quoin casings planed to fit the cast-iron heel-posts of the gates.

Two water-gauges, one above the upper gates, the other below the lower ones, were cut on the chamber side of the river wall. These gauges are referred to the lower miter-sill wall, which is 7 feet below low water.

The lock-gates were commenced September 12, and completed, practically, October 31.

The gates were built in place.

The length of the gates is 43 feet, height, upper gates, 20 feet 9 inches, lower, 22 feet 11 inches, through center, 4 feet seven-eighths inch exclusive of truss rods or hog chains.

The gates are suspended from cast-iron columns 14 feet 6 inches high, stayed by four 1¾-inch rods, held by 1¾-inch anchor-bolts, passing 6 feet into the wall, fox-keyed or wedged at their lower ends. The spaces between the anchor-bolts and the stone are filled with sulphur and sand.

Between the center of the hollow quoins and the center of the motion of the gate there is one-half inch eccentricity.

The lock-gates are opened and closed by means of cast-iron crabs, of single and double purchase, wrought-iron spars and three-quarter inch steel wire rope.

The filling of the lock is accomplished through sixteen valves placed in the head-bay platform, the water passing through eight culverts in the upper miter-sill wall.

The lock is emptied through sixteen valves in the lower gates.

The headbay platform is built of 14-inch by 14-inch and 8-inch by 14-inch oak timbers, planked over with 2-inch oak plank. Sixteen valves, 2 feet 6-inches by 3 feet 6 inches, are fitted into this platform and worked from the top of the walls by shafting and gearing. Two valves are connected on each shaft.

The valves in the lower gates, eight in each, of the same dimensions as those in the headbay, are worked in a similar manner, but separately.

Two gratings, made of 6-inch by 6-inch timbers and covered with 1¼-inch T-iron, placed 1¼-inches apart, protect the valves in the headbay.

Eighteen cast-iron snubbing-posts, held down by six 1-inch bolts, each fastened to the walls in a like manner to the anchor-bolts for the lock-gates, were placed, eleven on the land wall and seven on the river wall.

About 1,500 cubic yards of material were excavated from the tailbay and a mattress 50 feet long and 90 feet wide put in and well ballasted with large rubble-stone to a thickness to 2 to 2½ feet.

On the 8th of November the work for the season being completed, the lock-pit was flooded and Dredge No. 1 set to work to cut a channel through the lower end of the coffer-dam to take the boats into the lock to be laid in winter quarter, which was done on the 15th.

KAMPSVILLE LOCK.

No work was done at this place by the Government during the year.

Messrs. Sanger & Moody, contractors, Joliet, Ill., have delivered and piled the cut stone for courses A, B, C, D, I, K, L, and 124 pieces of O. R. coping. (Courses C and B of upper miter-sill wall have not yet been contracted for.)

The amounts of the different classes of stone delivered and piled are:

	Cubic yards.
Cut stone, dressed face	1,380.82
Cut stone, quarry face	843.31
Special stone, including 124 pieces of O. R. coping	657.63
Total	2,881.76

DREDGING.

Twelve Mile Island.—On March 25 Dredges Nos. 1 and 2, four dump-scows, coal barge, machine-shop, and office-boat, were towed by steamers *Hebe* and *Enterprise* from La Grange Lock to Twelve Mile Island, where the bar at the head of the island was to be removed by dredging.

The dredges commenced work on the 28th and completed the channel April 14. Eleven thousand one hundred and ninety-eight cubic yards of material were removed during this time. The dredged material was dumped at the head of the island, filling up the passage and making a dike 40 feet wide on top, 450 feet long, and about 3 feet above low water.

The breaking of two spuds on Dredge No. 1, and repairs to crane of Dredge No. 2, together with a continued rise in the river, backwater from the Mississippi, caused considerable delay.

The channel dredged is 85 feet wide, 4.5 feet deep at low water, and 2,000 feet long.

From soundings taken before the dredging commenced it was found that the channel was very narrow, with only 18 to 20 inches of water at low water.

At the completion of the dredging at Twelve Mile Island the fleet was moved to Kampsville.

Kampsville Lock.—The boats arrived here on the evening of the 16th and the dredges were set to work on the 17th.

The bar at this place was found at the lower end of the coffer-dam, and soundings showed the channel to be only 50 feet wide in one place; the average depth being only 2 feet at low water.

The dredged channel is 85 feet wide, 800 feet long, and 3.5 feet below low water, and required the removal of 7,645 cubic yards of material, which was dumped near the east bank of the river.

Dredging was completed April 24. On the 25th the tow was made up and a start made for La Grange Lock, which point was reached in the evening of the 27th.

The majority of the men employed during the dredging were discharged and those remaining engaged in laying up boats and dredges, care of property, etc.

La Grange Lock.—Advantage was taken of a rise in the river between May 28 and June 11, Dredge No. 1 fitted up and set to work to dredge material for filling in behind the land wall, steamer *Enterprise* being used for towing scows.

Seven thousand eight hundred and twenty-eight cubic yards of material were taken from the embankment at the lower end of the coffer-dam and dumped in the low space between the land wall and the bank. This work was stopped by the river commencing to fall. The dredge threw up a bank at the upper end of the land wall before being laid up.

SNAGGING.

Steamer *Enterprise*, with derrick-boat, was sent out July 1 to remove snags and other obstructions from the river channel between Copperas Creek Lock and the mouth of the river.

The snagging occupied nineteen days, and during this time 121 snags, logs, etc., were removed from the channel, 52 of these between Griggsville Bridge and McGee's Island, a distance of 5 miles.

At the time the snagging was done the river was practically at low-water stage, which greatly facilitated the work, as the men could, in most cases, work in the water fastening the hooks or chains around the snags, thereby saving much time.

REPAIRS AND ADDITIONS TO PLANT.

Dredge No. 1.—New dipper-handles and spuds were made for this dredge, new friction blocks for hoisting and backing-drums put in, and worn out hinges on dipper-door renewed, as were also the hoisting and backing chains.

Dredge No. 2.—The iron cranes had 250 loose rivets cut out and new ones driven, channel bars reinforced and the whole crane given a general overhauling. The dipper handles, one spud, and the hoisting chain were renewed.

Steamer Hebe.—The wheelhouses were repaired, a bucking-beam for towing dump-scows made, and the outside of the hull and wood-work painted.

Steamer Enterprise.—While working at Twelve-mile Island a blister formed on the port boiler. Boiler-makers were sent for from Saint Louis and the boiler patched. Ten new buckets were made and fitted to the Dowler wheels, bucket-arms straightened, and new holding-bolts for the buckets put in.

The machinery was taken apart, repaired, and replaced. It was found necessary to make new pins for nearly all connections, refit the links and reset the valves.

Office boat.—The inside of the boat and the roof were painted. New bitts were put in and part of the nosing renewed.

Flat-boats and dump-scows.—New decking was laid on two flat-boats and calked with one thread of oakum. Several new chains in the dump-scows were put in and doors repaired.

Machine and blacksmith-shop.—This is an addition to the plant and was built in September, on a flat-boat 80 feet long and 16 feet beam. One drill-press and one lathe were purchased, and these, together with hand-power machinery before on hand, have proved very useful, and especially so during the construction of the lock-gates.

Since this shop was built all repairs to machinery on steam-boats and dredges have been made on the work.

The boilers and machinery of pumping engines, pile-drivers, and overhead traveling machines, having been laid up for several years, were gone over, cleaned, and oiled.

MISCELLANEOUS.

The white-oak timber for the lock-gates was furnished by Messrs. William Towle & Co., Metropolis, Ill.

The iron and steel for lock-gates, filling valves, etc., furnished by Messrs. Williams, White & Co., Moline, Ill., was of excellent workmanship and required no refitting in being brought together.

The stage of the river during the entire year was lower than it had been for many years. Between July 1 and December 4 the river did not get above a 1-foot stage, and during August and September 0.3 feet above low water was the average. For several days, August 11 to 14, the river was 0.075 feet below low water of 1879.

Navigation was practically suspended, except for small boats, during the latter part of July, August, and September, both on account of the low stage of the river and bars at 12-mile Island and Kampsville.

The river was closed by ice December 21, and opened on February 19.

WORK TO BE DONE.

The following work is required to be done to complete the improvement:

At La Grange Lock.—The construction of the dam, the necessary guard banks and approaches to the lock. Puddling around the dam, abutment, and riprapping the banks. The open space between the land wall and bank to be filled in. The dredging of a channel, 150 feet wide and 2,000 feet long to 7 feet below low water, from the lower end of the lock to the channel in the river. The upper and lower ends of the coffer-dam removed.

At Kampsville Lock.—Only the coffer-dam and the foundation for the lock are completed. All other work, including the dam and the lock keeper's quarters, yet remains to be done; 2,881.76 cubic yards of cut stone have been delivered and piled; the balance of the stone is yet to be contracted for.

Dredging.—The dredging necessary to give a 7-foot channel at low water, between Copperas Creek Lock and the mouth of the river, was originally estimated to be about 2,200,000 cubic yards.

Very respectfully, your obedient servant,

G. B. HEGARDT,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following comparative tables are taken from the annual report of the Merchants' Exchange, Saint Louis, Mo., for the year 1887:

River tonnage by months.

RECEIPTS BY RIVER IN TONS, 1887 (AT SAINT LOUIS).

Months.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Ohio.	Cumberland and Tennessee.
January	100	5,765	.....	.....	.....	.....
February	1,170	13,000	3,650	195	3,075	1,745
March	6,265	31,075	28,465	1,210	10,815	2,845
April	13,365	23,625	17,695	1,975	7,015	2,780
May	15,270	31,920	15,505	2,995	40,235	3,140
June	13,835	25,065	2,560	2,080	26,420	3,460
July	21,880	40,740	3,045	7,620	8,265	2,450
August	23,235	27,940	1,855	7,285	8,600	1,585
September	15,275	18,395	2,090	2,430	8,825	2,265
October	13,565	22,170	2,395	1,140	8,420	1,505
November	7,395	17,655	1,150	770	.....	1,200
December	995	11,385	150	.....	.....	840
Total	132,400	268,735	78,560	27,700	121,670	23,815
1886	140,880	173,610	88,010	32,620	116,885	18,200

TONS OF FREIGHT SHIPPED BY RIVER, 1887.

Months.	Lower Mississippi.	Upper Mississippi.	Illinois River.	Missouri River.	Ohio River.	Cumberland and Tennessee.	Ouachita and Red rivers.
January	.....	.....	.....	.....	.....	.....	.....
February	57,280	370	.....	75	.....	1,235	2,020
March	77,135	1,470	2,970	1,070	5,180	1,785	.....
April	82,060	5,630	1,225	1,760	2,495	1,285	900
May	70,145	7,755	830	2,230	6,210	2,365	.....
June	47,675	6,880	220	2,405	3,200	2,655	.....
July	60,840	4,295	280	2,165	1,950	2,340	.....
August	37,005	2,760	.....	2,305	.....	3,210	.....
September	27,755	2,410	.....	2,210	.....	955	.....
October	44,110	2,265	1,360	220	.....	835	.....
November	15,220	2,335	240	140	.....	1,625	.....
December	18,840	.....	.....	.....	.....	425	450
Total	538,065	36,170	7,125	14,580	19,035	18,715	3,370

Statement showing movement in flour and grain by river, 1887.

RECEIPTS.

By—	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.
	Barrels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Upper Mississippi River boats	65,708	689,505	180,595	457,520	9,965	16,291
Lower Mississippi River boats	34,277	792,038	10,513	215	27	2,296
Illinois River boats	1,560	437,477	191,941	41,595	3,535	192
Missouri River boats	3,255	641,317	71,277	1,455	491	.....
Ohio, Cumberland, and Tennessee river boats	.....	.....	.....	65	.....	.....
Total receipts	104,800	2,560,337	454,326	500,850	14,018	18,779

SHIPMENTS.

New Orleans boats and barges	342,078	3,817,104	7,272,931	1,434,447	337	699
Vicksburg boats	178,928	826	358,842	343,485	2,129	.....
Memphis boats	22,834	376	42,102	65,690	443	35
Upper Mississippi River boats	1,567	.....	435	1,420	.....	.....
Illinois River boats	1,665	5,443	.....	180	.....	.....
Missouri River boats	248	254	1,521	4,050	101	.....
Ohio River boats	75	40,000	210,017	.....	.....	.....
Cumberland and Tennessee river boats	28,461	45	130,518	103,335	706	.....
Arkansas, Red, and Ouachita river boats	12,124	.....	15,387	18,540	.....	.....
Total shipments	587,980	3,864,048	8,031,753	1,971,147	3,716	734

H H 11.

IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this improvement as far as at present authorized is to secure a channel 200 feet wide and 16 feet deep from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the commerce of this region and to afford relief to the overcrowded port of Chicago.

The river and harbor act of July 5, 1884, appropriated $50,000 for the improvement of the section of the river from the mouth to the outlet of Lake Calumet, with the following proviso:

"That no part of said sum shall be expended until the right of way shall have been conveyed to the United States free from expense, and the United States shall be fully released from all liability for damages to adjacent property owners, to the satisfaction of the Secretary of War."

Parties interested in the improvement of this stream have busied themselves in procuring the necessary releases and right of way. The matter is now in the hands of the Department of Justice for examination of titles and preparation of the necessary legal papers.

Work will be commenced on this section of the river as soon as the terms of the act have been complied with.

The river and harbor act approved August 5, 1886, appropriated an additional sum of $30,000 for the improvement of this river, a part of which was designated by Congress to be used in dredging in the river between the Forks and one-half mile east of Hammond. This part was further divided at the State line between Indiana and Illinois.

The language of that part of the act which relates to this appropriation reads as follows:

Improving Calumet River, Illinois: Continuing improvement, $30,000; of which $11,250 are to be used between the Forks and one-half mile east of Hammond, Ind., $5,625 of which are to be used in dredging the river between the Forks and the State line of Illinois and Indiana, and $5,625 on the river at Hammond, Ind.: *Provided, however,* That no part of said sum, nor any sum heretofore appropriated except the said $11,250 for the river above the Forks, shall be expended until the entire right of way, as set forth in Senate Ex. Doc. No. 9, second session Forty-seventh Congress, shall have been conveyed to the United States free of expense, and the United States shall be fully released from all liability for damages to adjacent property owners, to the satisfaction of the Secretary of War; and if any of the owners of real estate required to be taken, or that is damaged for the purpose of straightening or widening that portion of the Calumet River for which the appropriation herein is now made, can not be induced to convey to the United States such real estate so required, and release their claim for damages caused by said improvement, or should the owner or owners be incapable of conveying and releasing, or should his or her name or residence be unknown, or he or she be a non-resident of the State of Illinois, it shall then be the duty of the United States attorney for the northern district of Illinois to immediately file a petition in any court having jurisdiction thereof, in the manner and as authorized by the laws of the State of Illinois in such cases, for the purpose of ascertaining the just compensation to be paid to the respective owners of the land taken or damaged: *Provided, however,* That the other owners of property and parties interested in said improvement shall first execute a bond to the United States, to be approved by the Secretary of War, for the payment of the costs of such proceedings, and to pay any judgment that may be rendered therein, and on failure to do so the proceedings shall be dismissed.

Under the terms of this act a project was submitted to the Chief of Engineers, by my predecessor, Maj. Thomas H. Handbury, Corps of Engineers, May 28, 1887, and which is found in full in the last Annual Report of the Chief of Engineers, page 2168.

Proposals for doing the work therein proposed were solicited June 28, 1887, and opened July 29, 1887.

With the approval of the Chief of Engineers, a contract was entered into with Mr. S. O. Dixon, of Racine, Wis., the lowest responsible bidder, who has completed his contract.

Under the provisions of this contract 37,743 cubic yards of material were dredged from the channel at Hammond, Ind., and 39,061 cubic yards at Burnham, Ill.

PROPOSED APPLICATION OF FUNDS ALREADY APPROPRIATED AND THOSE ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

When the provisions of the law are complied with it is proposed to apply the available funds and those asked for to carrying into execution the existing project, *i. e.*, to the purchase of the necessary machinery, and to dredging with a view to improve equally the channel throughout the section appropriated for, with a view to securing ultimately a channel 16 feet in depth and 200 feet in width throughout.

The estimated cost of this improvement, provided the Government owned the plant, is $425,000. If done by contract the estimate is $1,000,000.

It would be undoubtedly far more economical for the Government to do the work with its own dredges, if appropriations can be secured to keep the plant at work. But with irregular and insufficient appropriations, with consequent idle and constantly depreciating plant, the economy of that course is not so apparent.

The estimate herewith submitted is for both the upper and lower sections of the river, that have been appropriated for, and includes the entire stretch from the mouth of the river to one-half mile east of Hammond, Ind.

Money statement.

July 1, 1887, amount available	$79,227.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,323.02
July 1, 1888, balance available	68,904.48
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	118,904.48
Amount (estimated) required for completion of existing project	295,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

As the Calumet River and Harbor are so closely connected in their commercial relations, no commercial statistics are given in this place.

Abstract of proposals received and opened by Maj. Thomas H. Handbury, Corps of Engineers, U. S. Army, at Chicago, Ill., July 29, 1887, for dredging in the Calumet River between the Forks and one-half mile east of Hammond, Ind.

No.	Name of bidder.	Residence.	Price per cubic yard.
			Cents.
1	Robert Finch	Grand Haven, Mich	25
2	Green's Dredging Company	Chicago, Ill	35
3	Samuel O. Dixon	Racine, Wis	11
4	F. R. Crane	Chicago, Ill	23
5	Dodge & Petrie	do	23½

With the approval of the Chief of Engineers, a contract was entered into (August 11, 1887) with S. O. Dixon, the lowest responsible bidder for this work.

H H 12.

SURVEYS FOR THE HENNEPIN CANAL.

No additional surveys were made during the year for the Hennepin Canal or expenses incurred on account of the appropriation therefor which was assigned to this office.

Money statement.

July 1, 1887, amount available	$633.66
July 1, 1888, balance available	633.66

APPENDIX II.

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN, AND OF GRAND RIVER BELOW GRAND RAPIDS.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL. U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charlevoix Harbor and entrance to Pine Lake, Michigan.
2. Frankford Harbor, Michigan.
3. Harbor of Refuge at Portage Lake, Michigan.
4. Manistee Harbor, Michigan.
5. Ludington Harbor, Michigan.
6. Pentwater Harbor, Michigan.
7. White River Harbor, Michigan.
8. Muskegon Harbor, Michigan.
9. Grand Haven Harbor, Michigan.
10. Black Lake Harbor, Michigan.
11. Saugatuck Harbor, Michigan.
12. South Haven Harbor, Michigan.
13. Saint Joseph Harbor, Michigan.
14. Michigan City Harbor, Indiana.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 7, 1888.

SIR: I have the honor to submit herewith the annual reports relating to works of river and harbor improvement under my charge, for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

I I 10.

IMPROVEMENT OF CHARLEVOIX HARBOR AND ENTRANCE TO PINE LAKE, MICHIGAN.

Object.—To secure a navigable channel between Lake Michigan and Pine Lake by way of Round Lake.

Projects.—The earliest project, adopted in 1368 and revised in 1875–'76, was to dredge a channel between Lake Michigan and Round Lake 100

to 150 feet wide and protect its sides by close piling. This project was modified in 1876 by substituting crib-work for piling beyond the shore-line. The project for the channel between Round and Pine lakes was adopted in 1882 and contemplated a dredged channel 80 feet wide and 12 feet deep, protected by pile revetment.

Description and present condition of works.—The channel between Lake Michigan and Round Lake is protected by two crib-work piers extended by plank-beam revetments into Round Lake.

The north pier is 779 feet long, consisting of 302 feet of crib-work 20 feet wide, built in 1879 and 1881, and 40 feet of crib-work 20 feet wide and 427 feet of crib-work 16 feet wide built by local enterprise previous to 1873. The extension into Round Lake is by 984 feet of plank-beam revetment, of which 354 feet were built in fiscal year 1887–'88.

The south pier is 341 feet long, 301 feet being crib-work 20 feet wide, and 40 feet being crib-work 16 feet wide. The extension into Round Lake is by plank-beam revetment 1,493 feet long.

The distance between piers is about 160 feet at the entrance of channel and about 105 feet between revetments.

The channel between Round and Pine lakes is protected by pile revetments 12 feet wide, that on the north side being 339 feet long, and that on the south side being 366 feet long. The width of channel is 83 feet.

The crib-piers are in serviceable condition, but owing to the fact that the work stated to have been put in by local enterprise previous to 1873 was merely placed upon the natural bottom of the lake, it has never been possible to dredge the channel between the piers to its full width for fear of undermining. The plank-beam revetments are in some places, particularly on south side of channel, showing evidences of weakness. This is due to the fact that the work was never properly tied back, and pressure from the rear, together with the undermining in front, has, in some places, inclined it towards the channel.

The works in the upper channel are in good order.

Operations.—The contract with Luther E. Allen, in force at the close of the last fiscal year, was closed during the current year, and resulted in the construction of 354 feet of plank-beam revetment on the north side of the channel, in the removal of 4,500 cubic yards of dredged material from between the piers, and in the extension of the south pier 50 feet by a crib 20 feet wide and 12 courses high with 6 courses of superstructure. This crib was placed on a stone foundation on a site prepared by dredging. Some difficulty was apprehended in the construction of the plank-beam revetment from the Rifenburg Milling Company, whose grist-mill was located with its south face in dangerous proximity to the proposed line of revetment. The owners of the grist-mill feared that in dredging for the site of the revetment the foundation of their mill would be undermined, and had threatened legal proceedings. After conferring with the interested parties, the alignment was so chosen that no danger resulted from the disturbance of the ground in front of the mill. The site for the revetment was excavated to a depth of 8 feet, except in front of the mill, where it was only 6 feet deep; and the piling to retain the revetment was also made close along this portion, in order to insure greater stability. The space between the revetment and the natural bank was filled with edgings.

Present depth of water.—Owing to a shoal that is making around the end of the south pier, vessels drawing over 10 feet can not enter the channel. The difficulty will undoubtedly be obviated upon the extension of the south pier, and 12 feet of water will then be rendered practicable.

An extension of the south pier is urgently needed to intercept the shoal forming out from the shore and across the channel. The estimated length of this extension is 250 feet.

It is estimated that $50,000 can be profitably expended during the fiscal year ending June 30, 1890, in extending the south pier and in general repairs to piers and plank-beam revetments, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand Traverse. A beacon-light is shown near end of north pier.

Original estimated cost of work, 1868	$198,044.14
Amended in 1876	186,000.00
Whole amount appropriated from 1868 to 1888, inclusive	81,000.00
Whole amount expended	78,079.20

Money statement.

July 1, 1887, amount available	$10,289.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,368.38
July 1, 1888, balance available	2,920.80
Amount appropriated by act of August 11, 1888	12,500.00
Amount available for fiscal year ending June 30, 1889	15,420.80
Amount (estimated) required for completion of existing project	92,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS, CHARLEVOIX HARBOR, MICHIGAN, FROM JULY 1, 1887, TO JUNE 30, 1888.

Vessels entered and cleared	531
Tonnage	89,367

Articles entered and cleared.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Entered—continued:	
Merchandise ... tons	3,925	Fresh fish ... pounds	468,000
Iron ore ... do	25,500	Limestone ... tons	1,100
Coal ... do	3,000	Cleared:	
Lime ... barrels	1,500	Lumber ... feet, B. M.	20,000,000
Kerosene ... do	1,000	Shingles ... number	14,000,000
Wheat ... bushels	12,000	Hoops ... do	5,550,000
Corn ... do	18,000	Broom-handles ... do	65,000
Oats ... do	15,000	Railroad ties ... do	165,000
Feed ... tons	550	Posts ... do	112,000
Hay ... do	300	Wood ... cords	5,000
Brick ... number	47,500	Slabs ... do	2,000
Beer ... barrels	400	Bark ... do	8,000
Potatoes ... bushels	2,000	Merchandise ... tons	7,250

I I 2.

IMPROVEMENT OF FRANKFORD HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Lake Aux Bocs Scies and to make it a harbor of refuge.

Project.—The original project, adopted in 1866, was to dredge a channel 200 feet wide across the narrow strip of land separating the two

lakes and extending from the 12-foot curve in one to the 12-foot curve in the other, the sides of the cut to be protected by crib-piers and revetments.

The present project, adopted in 1881, contemplates the extension of the piers into a depth of 16 feet of water, where a rocky bottom is found. It is believed that if the piers were extended to this depth there would be no further trouble from shoaling at the harbor entrance.

Description and present condition of works.—The channel is protected on the north by 602 feet of crib-work 20 feet wide, and 396 feet of pile revetment 14 feet wide.

The south side of the channel is protected by 351 feet of crib-work 30 feet wide, 799 feet of crib-work 20 feet wide, and 187 feet of pile revetment 14 feet wide. These works are all in a good state of repair.

Depth of water.—The present available depth of water is 12 feet, as determined by soundings taken May 23, 1888.

No work was done during the fiscal year, the amount of money available being insufficient for undertaking any pier extension.

It is estimated that $50,000 can be profitably expended during the fiscal year ending June 30, 1890, in pier extension and such repairs as may become necessary, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is at Point Aux Becs Scies. A light is located near end of South Pier.

Original estimated cost of work, 1866, amended in 1875, and again in 1879	$254,196.00
The whole amount appropriated from 1865 to 1888, inclusive	255,659.85
Amount covered into Treasury (Report 1871, page 133)	5,721.50
Whole amount expended	246,618.42

Money statement.

July 1, 1887, amount available	$3,748.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	429.03
July 1, 1888, balance available	3,319.93
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	11,319.93
Amount (estimated) required for completion of existing project	65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Statement of the amount of commerce, July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Cleared:		Cleared—continued:	
Lumber ... feet, B. M.	39,693,000	Fruit ... barrels	1,800
Shingles ... pieces	2,506,000	Fish ... tons	332
Ties ... do	1,700	Entered:	
Posts ... do	5,000	Merchandise ... tons	222,858
Bark ... cords	2,810	Produce ... do	225
Slabs and wood ... do	7,970		

I I 3.

IMPROVEMENT OF HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Portage Lake, such as to make it a harbor of refuge.

Project.—The original project, adopted in 1879, was to dredge a channel 300 feet wide and 18 feet deep connecting the two lakes. The sides of the cut were to be protected by pile revetments extending into Lake Michigan by crib-work. Owing to the fact that temporary jetties built in 1879 were utilized subsequently as a foundation for the revetments, the present channel is 370 feet wide.

Description and present condition of the works.—The present works on the north side of the channel consist of 1,239 feet of pile revetment, 14 to 18 feet wide, filled with edgings, ballasted with stone, and 151.5 feet of crib-work 24 feet on the outer end. On the south side of the channel the works consist of 573 feet of pile-work 14 to 18 feet wide; 805 feet of pile revetments 14 feet wide filled with edgings ballasted with stone.

Owing to very stormy weather last fall some parts of the north revetment showed signs of spreading, the head of some of the ties pulling through the side timbers.

In order to temporarily secure the work, iron tie-rods passing across the whole work from front to rear were put into the work at the worst places.

The crib-work is in good condition. On the south side 573 feet of revetment from the western end of the pier will have to be rebuilt eventually as the piles were driven to an insufficient depth. The remainder of the revetment on the south side is in good condition, needing, however, additional filling.

Operations.—By contract.—The contract with Schwarz & Berner for placing two cribs, 50 by 24 feet, on pile foundation, which contract was in force at the close of the last fiscal year, was completed May 5, 1888. The north pier was thereby extended 100.4 feet. These cribs are 18 courses high with 6 courses of superstructure.

Owing to the extremely stormy weather in the latter part of 1887 the contractors were unable to complete the filling in of these cribs before winter set in, and their contract was extended, by authority of the Chief of Engineers, to May 15, 1888.

By hired labor.—The United States dredge *Farquhar* completed her work at this point on August 6, 1887, having commenced operations on the 20th of June previous.

A channel 50 feet wide and 13 feet deep was excavated over the same ground as covered by the dredging of previous years.

The United States dredge was again put to work in channel on the 25th of June, 1888.

During the fiscal year 11,094 cubic yards of material were removed by the dredge.

The inner of the three cribs on the north pier, built in 1883, which had settled very irregularly, was leveled up with the rest of the work and filled with stone.

Depth of water.—In consequence of the unusually low stage of water and the shoaling which is constantly taking place, owing to the very incomplete condition of the works, only 7.5 feet of water was available in May, 1888. The United States dredge *Farquhar* was therefore sent to this harbor to deepen the channel as far as the small sum available would permit.

Until the piers are extended into deep water, so that the channel can be excavated to a depth of 18 feet, dredging will be needed at short intervals to accommodate local commerce. If the approved project for a harbor of refuge at this point is ever to be carried out, sound economy would indicate that the appropriations be made large enough to complete the work in a reasonably short time. In the approved project 1,200 feet of crib-work were called for on the outer ends of the piers. Up to the present time, owing to insufficient appropriations, only 150 feet have been put in place. The annual dredging required is productive of only temporary benefits, and will add a large sum to the final cost of the work if the present insufficient appropriations are kept up.

I would therefore respectfully recommend that $150,000 be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Manistee, Mich.

Original estimated cost of work, 1879	$189,860.00
Whole amount appropriated from 1879 to 1888, inclusive	82,500.00
Whole amount expended	81,719.07

Money statement.

July 1, 1887, amount available		$12,260.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,299.95	
July 1, 1888, outstanding liabilities	179.65	
		11,479.60
July 1, 1888, balance available		780.93
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,780.93
Amount (estimated) required for completion of existing project		172,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics, harbor of refuge at Portage Lake, Michigan, from July 1, 1887, June 30, 1888.

Vessels entered and cleared	[illegible]
Tonnage	35,[illegible]

114.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan in [illegible] Manistee River and Lake.

Project.—The project now in force was adopted in 1866, and modifie[illegible] in 1870–1874, and is to secure a channel of navigable width and 12 fe[illegible] deep, the piers to extend to the 14-foot curve in Lake Michigan. Pre[illegible]ent width of channel at entrance, 180 feet.

Description and present condition of works.—On the north side of t[illegible] channel there are 1,040 feet of crib-work prolonged to eastward by 1,0[illegible] feet of pile revetment 14 feet wide. Of the crib-work 403 feet is 24 fe[illegible] wide, constructed in 1876–1882; 30 feet is 30 feet wide, constructed in 1872; 615 feet is 20 feet wide, constructed in 1868–1872.

The crib-work on the south side of the channel is 1,097 feet long, 200 feet being 30 feet wide, built in 1882–1887; 251 feet being 24 feet wide, built in 1876–1879; 30 feet being 30 feet wide, built in 1872, and 616 feet being 20 feet wide, built in 1868–1872.

The pile revetment on the south side is 490 feet long, 14 feet wide. The pile revetments both on the north and south sides are in need of repairs, the south side being especially bad. The crib-work is in fair condition.

Depth of water.—A navigable channel 12 feet in depth has been maintained throughout the year.

Operations.—A contract with Messrs. Schwarz & Berner for placing one crib 50 by 30 feet on pile foundation in extension of south pier was in force at the close of the last fiscal year. Work was commenced August 29, 1887, and completed November 22, 1887. The crib thus placed is 16 courses high with 6 courses of superstructure. It had been intended to fill the interval between this and the preceding crib with brush ballasted with stone, but after placing the crib, and before the superstructure had been added, the interval was completely filled with stone washed from the incomplete crib by a heavy gale, making it impossible to carry out the original design of a brush and stone filling. The approved project calls for an extension of the piers into 14 feet of water, and to accomplish this 300 feet of crib-work are still needed on the south pier and 200 feet on the north pier.

It is therefore respectfully recommended that $50,000 be appropriated for the fiscal year ending June 30, 1890, to be applied in pier extension and such repairs as may be necessary to existing work.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. A light is shown near the head of south pier.

Original estimated cost, 1866, amended 1875	$234,000.00
Whole amount appropriated, 1866 to 1888, inclusive	238,000.00
Whole amount expended	230,786.51

Money statement.

July 1, 1887, amount available	$12,891.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,678.39
July 1, 1888, balance available	7,213.49
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	17,213.49
Amount (estimated) required for completion of existing project	82,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics, Manistee Harbor, Michigan, from July 1, 1887, to June 30, 1888.

Vessels entered and cleared	3,459
Tonnage	889,879

I I 5.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

Object.—The original object of this improvement was to secure a channel of navigable width and 12 feet deep between Lake Michigan and Pere Marquette Lake. The present project is to make this a harbor of refuge.

Project.—To widen the present entrance to Pere Marquette Lake to 400 feet, and dredge the new channel to a depth of 18 feet. This will necessitate the construction of a new south pier and the removal of the present one.

Description and present condition of works.—(1) North pier, 947 feet long, of crib-work, 200 feet being 24 feet wide, built between 1879 and 1886; and 747 feet, 20 feet wide, built between 1868 and 1875, with one crib 30 by 30 feet, in this section. (2) South pier, 1,112 feet crib-work, 256 feet being 30 feet wide, built between 1878 and 1882, and 856 feet built between 1868 and 1874, with one crib 25 by 25 feet, in the last-mentioned section. (3) South revement and pile-pier 567 feet long. Both piers are in fair condition. As already stated, the project now in force provides for the removal of the entire south pier and revetment.

Depth of water.—At the beginning of the present season of navigation there was a depth of less than 12 feet. At the close of the present fiscal year there had been dredged a 15-foot channel which, however, can only be considered temporary.

Operations.—The only work done at this harbor during the present fiscal year was to dredge a channel for the temporary relief of navigation. This was done with the Government dredge and hired labor. Work was commenced June 4, and completed June 19, 1888, and resulted in the removal of 3,780 cubic yards.

The work of carrying out the present project has been delayed by the fact that no authority existed for the acceptance by the United States of a strip of land needed for the widening of the channel. An enabling act was passed by Congress, approved April 24, 1888, authorizing the acceptance by the United States of the above mentioned strip of land, which the Pere Marquette Lumber Company has offered to donate. Negotiations are now in process for the transfer of this land to the United States, and as soon as it shall have been effected work will be commenced on the present project with the funds available.

When once commenced, it is highly desirable that the work of widening the entrance shall be pushed continuously to completion, and it is, therefore, respectfully recommended that $250,000 be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand Au Sable. A light is shown near the end of south pier.

Original estimated cost of work, 1866, amended 1879	$213,787.07
And in 1885	419,185.20
Whole amount appropriated from 1868 to 1888, inclusive	292,435.00
Whole amount expended	237,057.19

Money statement.

July 1, 1887, amount available		$56,884.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$866.82	
July 1, 1888, outstanding liabilities	639.85	
		1,506.67
July 1, 1888, balance available		55,377.81
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		115,377.81

Amount (estimated) required for completion of existing project	$302,935.20
Amount that can be profitably expended in fiscal year ending June 30, 1890	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics, Ludington Harbor, Michigan, from July 1, 1887, *to June* 30, 1888.

Vessels entered and cleared	1,511
Tonnage	270,316

II 6.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Pentwater Lake, which is the harbor of Pentwater.

Project.—The present project, adopted in 1866, is to obtain a channel 150 feet wide and 12 feet deep, protected by piers extending into Lake Michigan and revetments to Pentwater Lake.

Description and present condition of works.—The north pier consists of 402 feet of crib-work, of which 233 feet is 30 feet wide and 169 feet is 20 feet wide, and 428 feet of pile-pier 14 feet wide. The revetment in extension of north pier is 1,393 feet long, pile-work 14 feet wide. The crib-work is in good condition, with the exception of the filling, which needs to be added to at several points, and particularly at two of the intervals between the 20-foot cribs.

The superstructure of the pile-pier needs renewal over a length of 380 feet, and overhauling of the filling. The pile revetment is in fair condition.

The south pier consists of 672.8 feet of crib-work, of which 53.8 feet is 30 feet wide, 32 feet is 32 feet wide, and the remainder 20 feet wide. Also 95 feet of pile-pier 14 feet wide. The revetment on the south side is 1,297 feet of pile-work 14 feet wide, with the exception of the filling, which needs adding to at several points; the crib-work on south side is in good condition. The pile-pier, 95 feet long, is badly decayed and its superstructure needs renewal.

The pile revetment on the south side is also decayed above water-line but will yet last a little time.

Depth of water.—Owing to the poor condition of the north pier, which allows the entrance of sand into the channel, a bar has formed opposite the shore end of the pier, over which there is only 9 feet of water.

Operations.—The contract made in previous fiscal year with Mr. C. E. Mitchell for placing one crib 50 by 30 feet on pile foundation was completed July 29, 1887. The crib is 16 courses high, with 6 courses of superstructure, and rests upon piles driven about 12 feet into the lake bottom. The space between the horns of crib at the end of the pier was filled with a timber structure screw bolted to the end wall and reaching from the water-surface to the top of work. By the addition of this crib the south pier was extended 53.8 feet. No work was done during the year by hired labor.

The project now in force calls for 250 feet of additional crib work on the south pier, and it is respectfully recommended that $40,000 be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is at Little Point Sable; a light is shown near head of south pier.

Original estimated cost of work, 1866, amended 1873	$192,620.00
Whole amount appropriated from 1866 to 1888, inclusive	217,820.00
Whole amount expended	212,605.22

Money statement.

July 1, 1887, amount available	$8,028.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,813.48
July 1, 1888, balance available	5,214.78
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	13,214.78
Amount (estimated) required for completion of existing project	37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	37,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS, PENTWATER HARBOR, MICHIGAN, FROM JULY 1, 1887, TO JUNE 30, 1888.

Vessels entered and cleared	900
Tonnage	80,000

Articles entered and cleared.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Cleared—Continued.	
Merchandise ... tons	21,000	Posts ... number	168,000
Cleared:		Ties ... do	7,000
Lumber ... feet, B. M.	27,000,000	Bark ... cords	2,000
Shingles ... number	23,000,000	Produce ... tons	1,000
Slabs and wood ... cords	1,000	Furniture and merchandise ... do	

117.

IMPROVEMENT OF WHITE RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into White Lake, Michigan.

Project.—Adopted in 1866, to dredge a channel 200 feet wide and 12 feet deep between the two lakes, and protect it by parallel piers and revetments.

Description and present condition of the works.—The north pier consists of 45 feet of pile-pier, 40 feet wide, in good condition; 411 feet pile-pier, 20 to 25 feet wide, at present undergoing repairs; 600 feet of pile-pier, 14 to 18 feet wide, 240 feet of which is being repaired; the remainder is in poor condition. The revetment in extension of this pier is 459 feet long, pile-work, 12 to 14 feet wide, and in good condition.

On the south side the pier is composed as follows: Fifty feet crib-work, 30 feet wide, in good condition, except that the outer end has settled somewhat; 51 feet of crib-work, originally 24 feet wide, but extended to 30 feet by pile-work, in good condition; 255 feet crib-work,

24 feet wide, in fair condition; 367 feet pile-pier, 19 to 24 feet wide, in fair condition; and 717 feet pile-work, 12 to 14 feet wide, 340 feet of which is in good condition, having been repaired in 1885-'86; the rest is in poor condition.

The revetment on the south side is 414 feet long, pile-work, 12 to 14 feet wide, and in good condition.

Operations.—During the previous fiscal year contracts were awarded for furnishing material for rebuilding the superstructure over a portion of the north pier, 695 feet long. The work was to be done by hired labor, and was commenced April 23, 1888. At the close of the fiscal year the old superstructure had been removed for a distance of 300 feet, the piles sawed off at .5 foot above zero of gauge, and two courses of superstructure completed for a distance of about 250 feet. The filling in this portion had also been overhauled and some new edgings and stone put in.

The available depth of water at the opening of the season of navigation was only 9 feet, and the United States dredge *Farquhar* was therefore fitted out at Grand Haven and sent to this harbor. Dredging commenced May 16, 1888, and terminated May 26, 1888. Two contiguous cuts, each 24 feet wide, were made, extending from the 12-foot contour inside to the 12-foot contour on the outside. In all, 4,190 cubic yards of sand were removed.

Present depth of water.—The present available depth of water is 12 feet.

A portion of the north pier, 310 feet in length, and of the south pier, 377 feet in length, needs new superstructure.

To do this and to extend the piers $50,000 can be profitably expended during the fiscal year ending June 30, 1890, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan, and is situated at the White River Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended 1873	$220,445.56
Whole amount appropriated from 1866 to 1888, inclusive	247,500.00
Whole amount expended	244,974.94

Money statement.

July 1, 1887, amount available		$10,275.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,245.95	
July 1, 1888, outstanding liabilities	1,465.71	
July 1, 1888, amount covered by existing contracts	988.32	
		$7,699.98
July 1, 1888, balance available		2,575.06
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		12,575.06
Amount (estimated) required for completion of existing project		74,225.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics White River Harbor, Michigan, from July 1, 1887, to June 30, 1888.

Vessels entered and cleared	1,742
Tonnage	184,247

118.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Muskegon Lake, which is the harbor of Muskegon.

Project.—The original project adopted in 1866, was to secure a channel of entrance of navigable width and to extend the piers beyond the bar to 17 feet soundings, modified in 1880 to increase the width of entrance from about 190 to 300 feet by a detached north pier.

Description and present condition of works.—The outer detached section of the north pier is 451 feet long, consisting of crib-work 30 feet wide, built in 1882–1888, and is in good condition. The inner old north pier consists of 638 feet of crib-work, 50 feet being 30 feet wide, built in 1880; 70 feet, 32 feet wide, built in 1871–1872; 518 feet, 20 feet wide, built in 1868–1870. This crib-work is all in fair condition. The extension of the north pier towards Muskegon Lake is by a pile revetment 392 feet long, 252 feet being 20 feet wide and 140 feet being 14 feet wide, built in 1874–1875. This revetment is in bad condition and requires renewal above the water-line.

The south pier consists of 550 feet of crib-work, 302 feet being 30 feet wide, built in 1875–1878, in fair condition, except pier-head, which has been damaged by collisions; 33 feet crib-work, 32 feet wide, built in 1869, in fair condition; and 215 feet crib-work, 20 feet wide, built in 1868, in fair condition. The extension of the south pier eastward is by pile-work 380 feet long and 20 feet wide, built in 1872–1874. This work is in a badly-decayed condition, and needs renewal above the water-line.

Depth of water.—The least depth of water between the piers is 15 feet. Owing to a shoal spot in advance of the piers, the available depth is reduced to 14 feet.

Operations.—By hired labor.—The repairs to the end of the old north pier, commenced in previous fiscal year, were completed by filling the work with stone and decking it over. Some stone filling was also placed in the old work of the north detached pier.

By contract.—In the previous fiscal year a contract had been entered into with Messrs. Schwarz & Berner, for placing two cribs 50 by 30 feet on pile foundation in extension of north detached pier. Crib No. 1 was sunk August 7, 1887, and Crib No. 2 was sunk on August 20, 1887. Owing to very severe weather, the contractors were unable to complete the work of placing the superstructure before the close of the season, and their contract was extended until June 15, 1888. During a severe storm October 2, 1887, the outer of the two new cribs was displaced from its foundation, its outer end moving about 5 feet to the north, and at the same time settling about 6 feet, the inner end remaining closely at its original elevation. The superstructure which had been made continuous over the two new cribs broke at their junction. The contractors did everything in their power to repair the damage and complete the contract before winter, but failed to do so on account of continued stormy weather. Early in the spring of the present year the contractors resumed work. The crib which had been displaced was leveled up and the superstructure placed. The intervals between the two new cribs was closed and filled with brush and stone and the contract completed May 31.

Extensive repairs are needed on the superstructures of the pile revetments on both sides of the channel, and some of the crib intervals on

north side need refilling. To enable these repairs to be made and also to extend the south pier in accordance with the existing project it is respectfully recommended that $100,000 be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan, and is situated at the Muskegon Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work 1866, amended in 1879	$168,901.75
Whole amount appropriated from 1866 to 1888, inclusive	234,000.00
Whole amount expended	232,685.82

Money statement.

July 1, 1887, amount available		$14,572.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,194.53	
July 1, 1888, outstanding liabilities	14.09	
		13,208.62
July 1, 1888, balance available		1,364.18
Amount appropriated by act of August 11, 1888		45,000.00
Amount available for fiscal year ending June 30, 1889		46,364.18

Amount (estimated) required for completion of existing project	56,125.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	56,125.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Commercial statistics, Muskegon Harbor, Michigan, from July 1, 1887, *to June* 30, 1888.

Vessels entered and cleared	6,272
Tonnage	1,176,148

I I 9.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

Object.—To secure a channel navigable in any weather from Lake Michigan into Grand Haven Harbor, which is a port of Grand River.

Project.—The project in force at present was adopted in 1866, and provides for securing a channel of navigable width (400 feet) with an available depth of 18 feet.

Description and present condition of the works.—The north pier has a total length of 1,360.6 feet, composed as follows: Seven hundred and fifty-eight and six-tenths feet of crib-work, of which 150.6 feet were completed the present fiscal year and the remainder between 1875–1879; 602 feet of pile work, 20–22 feet wide, built 1875. This work is all in fair condition, with the exception of the stone filling in the outer crib, which has settled considerably. The revetment in continuation of the north pier is 1,526 feet long, pile-work 14 feet wide, built in 1874, and is in good condition.

The south pier is 2,487.2 feet long, 653.2 feet being crib-work 30 feet wide, built in 1882–1886, in good condition, except the stone filling in the outer crib, which has settled several feet; 102 feet crib-work 24 feet wide,

built in 1869, and 294 feet crib-work 20 feet wide, built in 1868–1870. These last two sections were widened to 30 feet by a double row of close piling for new lake face and new superstructure of that width, in good condition; 1,438 feet of pile-work 15 to 30 feet wide, in poor condition, built in 1866–1871.

The south revetment, in continuation of the above, is 2,834 feet long of pile-work 14 feet wide, built in 1873–1882, in fair condition.

Depth of water.—The available depth of water between the piers is 18 feet. In the prolongation of the north pier is a bar over which there is a least depth of 15 feet, but the bar fortunately does not block the entrance.

Operations—by contract.—A contract was made in the previous fiscal year with Messrs. Schwarz & Berner for placing three cribs 50 by 30 feet in extension of north pier and one of the same dimensions in extension of south pier. The contract was completed October 7, 1887, and resulted in the addition of 52.2 feet to the south pier and 150.6 feet to the north pier.

By hired labor.—The old end crib of the south pier, which had settled irregularly, was leveled up and the superstructure rebuilt. The decking of the south pier between Stations 1 and 7 was repaired and the open interval at Station 4 was closed and filled.

Some minor repairs were made to the superstructure of pile-work between Stations 12 and 22.

With the balance available it is proposed to continue the work of pier extension and to make such minor repairs as may be necessary.

The permanent completion of this harbor depends upon the extension of the present piers, so as to secure a sufficient depth of water at the entrance to permit vessels to enter in any weather, and I would respectfully recommend the appropriation of $150,000 for this purpose, for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan, and is situated at the Grand Haven Lights.

Grand Haven is a port of entry.

Original estimated cost of work, 1866	$352,770.47
Whole amount appropriated from 1852 to 1888, inclusive	524,366.15
Whole amount expended	513,458.98

Money statement.

July 1, 1887, amount available		$37,931.22
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,901.05	
July 1, 1888, outstanding liabilities	123.00	
		27,024.05
July 1, 1888, balance available		10,907.17
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		35,907.17

Amount (estimated) required for completion of existing project	155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS, GRAND HAVEN HARBOR, MICHIGAN, FROM JULY 1, 1887, TO JUNE 30, 1888.

Vessels entered and cleared	1,888
Tonnage	1,036,629

Articles entered and cleared.

Articles.	Quantities.	Articles.	Quantities.
Entered:		Entered—continued:	
Merchandise ....tons..	366,902	Stone ....cords..	2,617
Flour ....barrels..	977,306	Sundries ....packages..	91,766
Pork ....do....	17,748	Cleared:	
Oil cake ....sacks..	20,977	Lumber ....feet B. M..	74,013,000
Feed ....do....	138,822	Shingles ....number..	19,441,500
Pig-iron ....tons..	1,088	Slabs ....cords..	6,031
Iron ore ....do....	35,929	Lath ....number..	300,000
Bullion ....bars..	13,439	Railroad ties ....do....	1,000,000
Letters ....packages..	15,927	Bark ....cords..	600
Rags ....bales..	3,606	Plaster ....barrels..	2,840
Wool ....sacks..	2,808	Apples ....do....	12,116
Peas ....barrels..	10,686	Fruit ....packages..	108,267
Tobacco ....cases..	3,859	Coal ....tons..	50
Lumber ....feet B. M..	500,000	Stone ....cords..	214
Coal ....tons..	2,200	Merchandise ....tons..	23,437
Beer ....kegs..	871	Pig-iron ....do....	6,000

I I 10.

IMPROVEMENT OF BLACK LAKE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into Black Lake, Michigan.

Project.—The present project was adopted in 1866, and modified in 1873, and provides for a channel of navigable width and not less than 12 feet deep.

Description and present condition of works.—(1) North pier 713 feet long, as follows: Two hundred and fifty-three feet crib-work, 24 feet wide, built in 1875–'80, in good condition; 32 feet crib-work, 32 feet wide, built in 1871, with superstructure 24 feet wide, built in 1885, in good condition; 259 feet crib-work, 20 feet wide, built 1868–'69, end crib resuperstructured in 1884, in good condition; 123 feet crib-work of irregular width, built previous to 1866, resuperstructured in 1884, in good condition; and 46 feet of crib-work, 20 feet wide, built in 1868, resuperstructured in 1884, in good condition. The north revetment, in continuation of the above, is 1,137 feet long, of pile-work, 549 feet being 14 feet wide, built in 1870, and 588 feet 16 feet wide, built in 1870–'73; 34 feet of this revetment was rebuilt above the water-line in 1884; the remainder is in very bad shape. (2) South pier, 691 feet crib-work, 252 feet being 24 feet wide, built 1875–'80, end crib resuperstructured in 1885–'86, in good condition; 298 feet 20 feet wide, built 1868–'70, resuperstructured in 1885; 77 feet of irregular width, resuperstructured in 1885, in good condition; 64 feet 20 feet wide, built in 1868, resuperstructured in 1885, in good condition; and 150 feet pile-pier, 14 feet wide, built in 1870 and resuperstructured in 1885.

The revetment in continuation of south pier is 707 feet long, of pile-work 14 feet wide, built in 1871–'74, in bad condition, except 101 feet, which was resuperstructured in 1886.

The old wing, 323 feet long, is not regarded as of sufficient importance to the improvement to warrant any work of repair being done to it.

Present depth.—The present available depth is not more than 7 feet between the piers.

Operations during the fiscal year.—Estimates and plans have been prepared for rebuilding superstructure on north pile revetment for a length of 515 feet. Contracts for furnishing the material were made in the previous fiscal year. The work is to be done by hired labor.

On June 30 the timber and iron had been delivered and the work of resuperstructuring commenced.

No further pier extension is called for at this harbor, but repairs on the existing revetments are urgently demanded. The extent of the repairs at present called for is as follows: On north side of the channel 588 feet of pile revetment, and on the south side of channel 605 feet need new superstructure.

The south pile revetment should be extended into Black Lake 150 feet to close gap between the present end of the revetment and the old wing, as the waters of the lake are washing out the shore-line at this point. The present depth of water is insufficient for the needs of commerce, and the channel should be dredged to a depth of 10 feet.

In the last Annual Report it was estimated that $15,000 would be required to complete the work of repairing the pile revetments, and it is estimated that this amount will be sufficient to leave a small sum available for closing the gap between the end of the present south revetment and the old wing and also to dredge a channel of 10 feet between the piers, as the amount of material to be removed is small. It is therefore recommended that $15,000 be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan, at Holland Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866	$106,238.04
Whole amount appropriated from 1852 to 1888	259,615.31
Whole amount expended	257,091.50

Money statement.

July 1, 1887, amount available		$6,761.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,732.20	
July 1, 1888, outstanding liabilities	160.29	
July 1, 1888, amount covered by existing contracts	1,344.75	
		4,237.24
July 1, 1888, balance available		2,523.81
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,523.81

Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

II 11.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to the harbor of Kalamazoo River, Michigan.

Project.—The present project is to merely maintain existing works and to keep a channel of entrance 10 feet deep by dredging.

Description and present condition of works.—The north pier consists of 375 feet of pile-work, 14 to 18 feet wide, built in 1875, in poor condition.

The north revetment in continuation of pier is 339½ feet long, of pile-work 14 feet wide, built in 1875–'76. Around the bend and on the same side of the river is a pile revetment 1,193 feet long and 14 feet wide. The interval between the two revetments is 1,750 feet. All the revetment is in poor condition.

The south pier is 286 feet long, of pile-work 20 feet wide, built in 1874, and in poor condition. The revetment on this side consists of 3,577 feet of pile-work, of which 834 feet is 24 feet wide and the rest 14 feet wide. With the exception of 1,334 feet at the inner end, this revetment is in a dilapidated condition.

With the exception of the portion of the south revetment above alluded to all the works require renewal above the water-line.

Depth of water.—From soundings made in June, 1888, an available depth of 8.5 feet is shown.

Operations.—During the fiscal year the work of rebuilding the superstructure of a portion of the south revetment at the inner end was commenced August 7, 1887, and completed June 16, 1888. The work was done by hired labor, the material being furnished under contracts made in the previous fiscal year. A total length of 1,334 feet of the inner portion of the south revetment was resuperstructured with four courses of 12 feet by 12 feet timbers, and two tiers of cross-ties, 8 feet between centers. New piles were driven by the United States pile-driver in the gaps of the old work, and the filling brought up by the addition of brush and stone ballast.

The condition of the timber-work above the water-line is such as to require attention at an early date, and it is respectfully recommended that $5,000 be appropriated for the fiscal year ending June 30, 1890, to be used in making repairs.

This work is located in the Michigan collection district, Michigan, and is situated at the Kalamazoo Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, modified 1869	$86,398.56
Whole amount appropriated from 1868 to 1888, inclusive	135,439.00
Whole amount expended	134,455.63

Money statement.

uly 1, 1887, amount available		$10,648.52
nly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,651.54	
uly 1, 1888, outstanding liabilities	13.61	
		9,665.15
uly 1, 1888, balance available		983.37
mount appropriated by act of August 11, 1888		5,000.00
mount available for fiscal year ending June 30, 1889		5,983.37
Amount that can be profitably expended in fiscal year ending June 30, 1890		5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Statement of the amount of commerce from July 1, 1887, to June 30, 1888.

Articles.	Quantities.	Articles.	Quantities.
Cleared:		Cleared—Continued.	
Lumber ..... feet B. M..	1,000,000	Veal ..... carcasses..	630
Shingles ..... pieces..	600,000	Chickens ..... coops..	197
Lath ..... do....	100,000	Dried fruit ..... boxes..	450
Peaches ..... baskets..	700,000	Merchandise ..... tons..	10
Berries ..... crates..	1,000	Entered:	
Apples ..... barrels..	12,047	General merchandise ..... do...	2,500
Potatoes ..... sacks..	1,755	Drain tile ..... do...	100
Flour ..... barrels..	400	Coal ..... do...	250
Fish ..... tons..	12½		

II 12.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

Object.- To secure a navigable channel from Lake Michigan into South Black River, Michigan, which is the harbor of South Haven.

Project.—The present project, adopted in 1866, and modified in 1879, was to obtain a channel of navigable width and not less than 14 feet deep.

Description and present condition of works.—The north pier consists of 606 feet crib-work, 255 feet being 32 feet wide, built in 1872–'74; 30 feet 30 feet wide, built in 1877, and 321 feet 20 feet wide, built in 1868–'69, all in fair condition. The north revetment in continuation of the pier is 986 feet long, 524 feet being pile-work 14 feet wide, built in 1876, and 462 feet plank-beam, built in 1879, in serviceable condition.

The south pier consists of 555 feet crib-work, 53 feet being 30 feet wide, completed in present fiscal year; 150 feet being 32 feet wide, built in 1871–'74, and 352 feet 20 feet wide, built in 1868, in fair condition. The south pier is extended eastwards by a revetment 998 feet, 143 feet being pile-work 14 feet wide, built in 1878, and 855 feet plank-beam, built in 1878–'82, in serviceable condition.

Operations: By contract.—The work of placing one crib 50 by 30 feet on pile foundation in prolongation of south pier, commenced in previous fiscal year, was completed July 22, 1887. The contractors were H. B. Herr & Co., of Chicago. The new crib is twenty-two courses high, the top of superstructure being 7.3 feet above zero of gauge. The south pier was extended 53 feet by this addition.

By hired labor.—In the spring of 1888 there was a depth of only 9 feet in the channel for a distance of 300 feet, and even less at other points above.

With the consent of the authorities of Michigan City, Ind., the Michigan City dredge was sent to this point to deepen the channel as far as available funds would permit. The dredge, after having been fitted out at Michigan City, commenced dredging May 9, 1888. On May 12 the available funds had been exhausted, resulting in the removal of 1,750 cubic yards of mixed material from a cut 13 feet deep, 28 feet wide, and 345 feet long.

Present depth of water.—The present available depth of water in the channel is 10 feet.

There still remains a considerable amount of dredging to be done near the outer ends of the piers, and some of the filling in the piers and

revetments needs overhauling. To obtain a more permanent deep-water channel it will be necessary to extend the piers further out, and it is respectfully recommended that $40,000 be appropriated to be applied for the purposes mentioned.

This work is located in the Michigan collection district, Michigan, and is situated at the South Haven Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866	$128,288.47
Whole amount appropriated from 1866 to 1888, inclusive	182,000.00
Whole amount expended	181,980.05

Money statement.

July 1, 1887, amount available		$9,781.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,633.07	
July 1, 1888, outstanding liabilities	128.92	
		9,761.99
July 1, 1888, balance available		19.95
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,019.95
Amount (estimated) required for completion of existing project		67,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics, South Haven Harbor, Michigan, from July 1, 1887, to June 30, 1888.

Vessels entered and cleared	420
Tonnage	29,134

I I 13.

IMPROVEMENT OF SAINT JOSEPH HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to the harbor of Saint Joseph, Mich.

Project.—The present project was adopted in 1866 and modified in 1874, and is to secure a channel of entrance of navigable width and not less than 16 feet deep.

Description and present condition of works.—The north pier from the outer end of the angle is 456.7 feet long, 100 feet being crib-work, 30 feet wide, built in 1880–'81, and the remainder, crib-work, 24 feet wide, built in 1875–'78, all in good condition.

From the angle inshore there is a section of crib-work 24 feet wide, which, for 242 feet, is in fair condition. The next section of 131 feet should be rebuilt. The prolongation of the pier eastward is by pile revetment, 696 feet long and 14 to 16 feet wide. The inner 66 feet is a total wreck, having been destroyed in the winter of 1886–'87.

The south pier consists of 213 feet of old crib-work, 24 feet wide at the eastern end, and 606 feet of pile-work, 14 feet wide. The outer 325 feet of the south pier is in a bad state and needs early attention.

The north bank of the Benton Harbor Canal was revetted by the Cincinnati, Wabash and Michigan Railway Company in 1882.

By the terms of the original agreement the company was to revet the entire north bank in consideration of the United States widening the canal beyond what was called for by the original project. The United States constructed, in 1881 and previous years, 1,585 feet of plank-beam revetment on the north bank of the canal, joining at its western end the wing-dam, 720 feet long, built in 1874–'79. The wing-dam is in fair condition, but the plank beam can hardly be called serviceable at present.

Depth of water.—Across the bar and between the piers there is a depth of 16 feet. In the short stretch from the railway bridge to the beginning of the piers there is a depth of 12 feet and in the canal 13 feet.

Operations.—By hired labor. The filling of the new pile revetment on the north side having settled was overhauled, additional brush being added to bring it up to the cross-ties, and the stone ballast replaced. On the south side the old work at the inner end for a length of 476 feet had its superstructure and filling renewed. This work was commenced early in July, 1887, and continued until the close of the season. It is contemplated to renew the superstructure of the remainder of the pier as soon as funds become available.

Early in the present spring it was found that there was not a sufficient depth of water in the Benton Harbor Canal for the needs of commerce; in fact, one steamer was reported as having grounded. After the completion of its work at South Haven the Michigan City dredge was sent to this place to deepen the canal and winding basin. The dredge arrived on May 27, and after spending two days on some necessary repairs to machinery commenced work on May 30 in the basin.

The winding basin at the head of the canal was dredged out to a depth of 13 feet, and a cut 28 feet wide and 13 feet deep was commenced in the center of the canal. This latter cut was completed for a distance of 905 feet from lower end of basin. Two adjunct cuts, each 28 feet wide, 14 feet deep, and 380 feet long, were made across the bar at foot of canal in Saint Joseph River.

The total quantity removed up to end of fiscal year was 14,850 cubic yards of mixed material.

To carry out the present plan of improvement for the harbor proper of Saint Joseph below the railway bridge, it is estimated that $41,015 will be required, and I would respectfully recommend that this amount be appropriated for the fiscal year ending June 30, 1890.

This work is located in the Michigan collection district, Michigan, and is situated at the Saint Joseph Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work as now being carried on	$128,288.47
Whole amount appropriated since adoption of present project, from 1836 to 1888, inclusive	342,613.00
Transferred to Grand Haven (Report 1870, page 44)	500.00
Whole amount expended	341,607.00

Money statement.

July 1, 1887, amount available		$4,544.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,693.52	
July 1, 1888, outstanding liabilities	1,345.95	
		4,039.
July 1, 1888, balance available		505.
Amount appropriated by act of August 11, 1888		12,000.
Amount available for fiscal year ending June 30, 1889		12,505.

Amount (estimated) required for completion of existing project	$29,015.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	29,015.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS, SAINT JOSEPH HARBOR, MICHIGAN, FROM JULY 1, 1887, TO JUNE 30, 1888.

Vessels entered and cleared	679
Tonnage	208,797

Articles entered and cleared.*

Articles.	Quantities.	Articles.	Quantities.
Cleared:		Cleared—Continued.	
Berries ..... crates..	400,000	Turnips and potatoes .... sacks..	20,000
Fruit ..... baskets..	325,000	Cider ..... packages..	25,000
Melons ..... crates..	60,000	Lumber ..... feet B. M..	20,000,000
Apples ..... barrels..	150,000	Merchandise ..... tons..	100,000

*No report.

I I 14

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

OUTER HARBOR.

Object.—To secure a harbor of refuge suitable for all classes of vessels engaged in commerce on the Lakes.

Project.—The first project for an exterior harbor to the east of entrance was adopted in 1870 and modified in 1872, 1875, 1876, and 1877. The second project for a western breakwater was adopted in 1882.

Description and present condition of the works.—The present outer harbor lies to the east of the entrance and consists of a crib breakwater, whose general direction is parallel to the shore, and a pile-pier, from the eastern end of the breakwater to the shore. The works are in fair condition. The entrance to the inner harbor consists of two piers of mixed construction, partly pile-work, partly crib-work. The distance between the piers is 100 feet. The west pier was overhauled during the preceding and present fiscal year and is in a good condition. The east pier is in a dilapidated condition at its outer end.

Operations.—The work of rebuilding outer end of west pier and renewing the superstructure of this pier from shore-line out was continued during the present year by hired labor and purchased material. The pile portion of the west pier, a length of 542½ feet, was practically rebuilt by driving a row of close piles completely around it. These piles were driven close up to the old work and sawed off at an elevation of 6 feet above zero of gauge; two courses of superstructure were put on, screw-bolted to the sides of piles and a wale-streak at the water-surface. The entire west pier from shore-line out was filled with brush and stone and the crib portion decked over. Some repairs of broken timbers were also made on the breakwater, and stone filling put in wherever there were empty pockets. The decking of the breakwater was thoroughly overhauled. The above work was completed at the end of November,

1887. During the winter some necessary repairs were made to the Government plant.

Estimates.—To complete the new east breakwater pier and construct the west exterior breakwater, in accordance with the report of the Board of Engineers constituted by Special Orders, No. 19, Headquarters Corps of Engineers, U. S. Army, dated Washington, D. C., March 2, 1882, to consider and report upon the improvement of the harbor at Michigan City, Ind., it was estimated by Major Smith that it would require $450,000 (page 1968, Report of Chief of Engineers, 1884), and as the construction of the breakwater, when once commenced, should be pushed to completion as rapidly as possible, I would respectfully recommend that $250,000 be appropriated for the fiscal year ending June 30, 1890, to be applied to construction of west exterior breakwater and completion of the breakwater at entrance. The views and recommendation of the Board of Engineers mentioned above were concurred in by the Chief of Engineers under date of July 6, 1882.

This work is located in the collection district of Chicago. The nearest light-house is Michigan City. The nearest port of entry is at Chicago, Ill.

Original estimated cost of work, 1857, amended 1870 and 1882	$587,000.00
Whole amount appropriated from 1836 to 1888, inclusive	868,793.59
Whole amount expended	847,889.76

Money statement.

July 1, 1887, amount available		$38,397.59
July 1, 1888, amount expended during fiscal year, exclusive of liabilties outstanding July 1, 1887	$17,268.05	
July 1, 1888, outstanding liabilities	225.71	
		17,493.76
July 1, 1888, balance available		20,903.83
Amount appropriated by act of August 11, 1888		90,000.00
Amount available for fiscal year ending June 30, 1889		110,903.83

Amount (estimated) required for completion of existing project	305,625.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

INNER HARBOR.

Object.—To obtain a suitable harbor for vessels by dredging Trail Creek.

Project.—The first project was adopted in 1870, and provided for deepening the channel up to the Railroad Bridge. The second project was adopted in 1878, and provided for making the length of the inner harbor 2,700 feet, its width 120 feet, and its depth 15 feet.

Operations.—The dredging commenced by the United States equipment in previous fiscal year near the Michigan Central Railroad Bridge was completed. At the west side of the harbor a cut was made, commencing at north line of basin and extending from there a distance 415 feet. This was made to allow vessels to get to the new salt-works. A total of 4,510 cubic yards was removed from the two localities.

With the balance available it is proposed to continue the work dredging as soon as the United States dredging equipment completes its work at Benton Harbor.

Depth of water.—Throughout the year a channel of sufficient depth for the needs of commerce has been maintained.

To complete the dredging of the river harbor it is estimated that ,000 will be required, and it is respectfully recommended that this ount be appropriated for the fiscal year ending June 30, 1890.

Small appropriations will probably be required from time to time to ep the channel clear.

ginal estimated cost of work 1870, amended 1878	$100,000.00
ole amount appropriated, 1878 to 1888, inclusive	96,875.00
ole amount expended	93,896.43

Money statement.

y 1, 1887, amount available	$3,293.25
y 1, 1888, amount expended during fiscal year, exclusive of liabilities utstanding July 1, 1887	314.68
y 1, 1888, balance available	2,978.57
ount appropriated by act of August 11, 1888	5,000.00
ount available for fiscal year ending June 30, 1889	7,978.57

MMERCIAL STATISTICS, MICHIGAN CITY HARBOR, INDIANA, FROM JULY 1, 1887, TO JUNE 30, 1888.

sels entered and cleared	1,167
nage	213,074

Articles entered and cleared.

Articles.	Quantities.	Articles.	Quantities.
ered:		Entered—Continued:	
Lumber ..... feet, B. M..	105,138,039	Stone ..... cords..	434
Lath ..... pieces..	24,202,410	Cleared:	
Shingles ..... do....	102,340,500	Hay ..... tons..	150
Posts, cedar ..... do....	76,000	Oats ..... bushels..	12,600
Wood ..... cords..	700	Iron rails ..... tons..	200
Pig iron ..... tons..	1,615	General merchandise ..... do..	300
Salt ..... barrels..	90,496	Sand ..... cubic yards..	6,000

APPENDIX J J.

EMENT OF ST. MARY'S RIVER—ENLARGEMENT OF AND OPERAT-
T. MARY'S FALLS CANAL—CONSTRUCTION OF HARBOR OF REF-
ON LAKE HURON AND IMPROVEMENT OF CERTAIN HARBORS ON
HURON AND OF SAGINAW RIVER—PRESERVATION OF AND OP-
NG ST. CLAIR FLATS CANAL —IMPROVEMENT OF GROSSE POINT
NEL AND OF DETROIT RIVER.

OF LIEUTENANT COLONEL O. M. POE, CORPS OF ENGINEERS,
BRIG. GEN., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR
NG JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE*
S.

IMPROVEMENTS.

ry's Falls Canal and River, Mich-
ting and care of St. Mary's Falls
l, Michigan.
ock at St. Mary's Falls Canal,
igan.
ake Channel, St. Mary's River,
igan.
r at Sheboygan, Michigan.
r at Thunder Bay, Michigan.
r at Au Sable, Michigan.
w River, Michigan.

9. Harbor of refuge at Sand Beach, Lake Huron, Michigan.
10. Steam-launch or tug for harbor of refuge at Sand Beach, Lake Huron, Michigan.
11. Ice-harbor of refuge at Belle River, Michigan.
12. Clinton River, Michigan.
13. St. Clair Flats Canal, Michigan.
14. Operating and care of St. Clair Flats Canal, Michigan.
15. Grosse Point Channel, Michigan.
16. Detroit River, Michigan.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 9, 1888.

I have the honor to transmit herewith the annual reports re-
o the works of river and harbor improvements under my charge
fiscal year ending June 30, 1888.
am, sir, very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

CHIEF OF ENGINEERS, U. S A.

J J 1.

IMPROVEMENT OF SAINT MARY'S FALLS CANAL AND RIVER, MICHIGAN.

This improvement, projected to obtain a 16-foot navigation between Lakes Superior and Huron, has been completed accordingly, at a cost of $2,404,126.32, exclusive of the grant of 750,000 acres of land to the State of Michigan, from the proceeds of which the canal was originally built, and excluding all expenditures on account of Hay Lake Channel. (For details see page 1785, Annual Report of the Chief of Engineers for 1886.)

Previous to its completion the available depth had been but 12 feet, and as soon as the additional depth was obtained the size and draught of vessels was increased to correspond with an enormous increase in the amount of commerce, until it is now evident to all that a further enlargement of the facilities must be made as soon as possible.

The river and harbor act of August 5, 1886, having provided for beginning the work of enlarging the canal, and appropriated the sum of $250,000 for "continuing improvement by a new lock and approaches," thus giving the sanction of both the legislative and executive branches to the proposition, it is deemed unnecessary to further pursue the subject.

Following the passage of that act, a general project for the work of enlargement was submitted, based upon a navigation of 20 feet in depth. This included a new lock 800 feet long between gates, 100 feet wide throughout, with 21 feet of water on the miter-sills and overcoming the difference of level with a single lift (approximately 18 feet), to be located upon the site occupied by the combined locks in the original construction of the canal, with the requisite deepening of the canal prism.

This was duly approved by the War Department, whereupon definite estimates of cost were submitted. They were printed as House Ex. Doc. No. 72, Forty-ninth Congress, and reprinted at pages 2220, *et. seq.*, Annual Report of the Chief of Engineers, 1887.

A project for the expenditure of the appropriation of August 5, 1886, was submitted under date of October 18, 1886, and duly approved. It had in view the construction of a coffer-dam 1,500 feet long and 300 feet wide to inclose the site of the new lock, the estimated cost being $195,392, and operations upon this work have been in progress since May 4, 1887.

The following contracts have been in force during the fiscal year, viz:

Date.	Contractors.	Contract for —
Dec. 22, 1886	Chauncey E. Mitchell	Furnishing lumber.
Dec. 22, 1886	Ducharme, Fletcher & Co.	Furnishing iron bolts and spikes.
Dec. 22, 1886	Chauncey E. Mitchell	Framing, placing, filling, and completing cribs.
Dec. 22, 1886	Carkin, Stickney & Cram	Furnishing and placing puddling clay.
Dec. 22, 1886	Hickler & Green	Furnishing dredge, tug, and two dump-scows.
June 24, 1887	Carkin, Stickney & Cram	Furnishing dredge, tug, and two dump-scows.
April 3, 1888	Hickler & Green	Drilling and blasting.
Oct. 24, 1887	H. D. Edwards & Co.	Ship chandlery.
Dec. 7, 1887	Johnson & Goss	Lumber and shingles.
Dec. 7, 1887	George Kemp	Coal.
Oct. 22, 1887	T. B. Rayl & Co.	Hardware.

The contract with Chauncey E. Mitchell for lumber has been completed by the delivery of 2,635,847 feet B. M., amounting at the con-

tract price to $37,428.92. That with Ducharme, Fletcher & Co., was completed by the delivery of 162,410 pounds drift-bolts, and 13,947 pounds of boat-spikes, aggregating $4,651.23.

The contracts with H. D. Edwards & Co., and T. B. Rayl & Co., were small in amount. They were duly completed and closed.

The remainder of the contracts enumerated above are still in force.

The two dredges employed by the hour have been engaged, for a large part of the year, in removing all of the loose material overlying rock sufficiently solid for the foundation of the coffer-dam (item 1 of the estimate). The excavation for all the crib-work has been completed. The dredge cut for the puddle-wall on the north side of the site for the lock has been carried about 150 feet above the upper end of the old locks. At the upper or northwest angle about 165 feet of the trench for the puddle-wall has been excavated by hand. This leaves about 460 linear feet of trench yet to be excavated.

All except five of the cribs required for the pier extension and coffer-dam have been built, placed in position, and filled, making a total of 1,224 linear feet. The five cribs not yet placed have been framed, and all but three courses bolted. They belong at the upper and lower ends of the coffer-dam. The placing of those belonging to the upper end is deferred for our convenience in placing the clay puddle in the dam, and the others for the purpose of affording access to and from the lock-pit during its excavation. The upper end of the dam will be closed this season, but the lower opening will be kept open until it becomes necessary to pump out the lock-pit. All of the superstructure of the permanent pier is completed.

During the fiscal year 2,115.91 cubic yards of clay puddling were placed in the coffer-dam. In making the connection between this puddling and the masonry of the lock-walls great care was exercised to have the masonry free from all dirt or other matter which might impair the efficiency of the dam.

Preparatory to the construction of a pier in front of that portion of the Fort Brady military reservation set apart for canal purposes (item 9 of the estimates), all of the shoal in front of a line adopted as the face of the pier, extending from the angle in the pier at the east boundary of the United States canal lands to the 20-foot curve at the eastern boundary of the Fort Brady reservation, was removed to a depth of 20 feet. For this purpose one of the dredges employed by the hour was used at such times as employment could not be given it on the coffer-dam nor in the canal. The shoal protruded about 150 feet in front of the line indicated.

The dredging was done by Hickler & Green's dredge No. 6. The time consumed in this work was 611½ hours; the quantity of material removed was 32,165 cubic yards; the cost was $7,026.50, or 21.84 cents per cubic yard. The material consisted of sand, mud, and some loose stone.

The required dredging is completed, with the exception of one-half of the cut for the pier site. The total length of the proposed pier is about 1,300 feet. Plans have been prepared for its construction, and the work should be done at the earliest practicable moment, to afford additional pier room to vessels compelled to wait either for lockage when bound up, or for daylight when bound down.

The shoalest water in the canal was at the point where the railroad bridge crosses it, and many vessels grounded there. To prevent serious interference with the operations of the draw, it was imperative that the canal be deepened at that point for a distance of about 700 feet im-

mediately above the movable dam. The work is included in item 7 of the estimates. Some progress was made towards it during the season of 1887, by the use of the drilling and blasting plant belonging to the Government, but the machinery was old, nearly worn out, and finally broke down. It was thought best not to make any attempt to renew it, but rather to have the drilling and blasting done by contract, the broken material to be removed by one of the dredges already under contract by the hour. After due advertisement for proposals the contract was awarded to Hickler & Green, the lowest bidders. They began operations as soon as the ice would permit, and have nearly completed their portion of the work. At present there is a depth of 18 feet in the north half of the canal at the site of the railroad bridge extending 700 feet westward from the movable dam, and the other half will have been removed before the end of this season.

It is probable that the present available funds will suffice to construct the coffer-dam. They certainly will do so unless some unforeseen difficulties should be developed as the work progresses. Consequently the next appropriation can be devoted to the excavation of the lock-pit, building culverts, and lock floor, etc., depending upon its amount. The larger the appropriation the more work can be put under contract, and the more rapidly it can be pushed forward. The estimate for excavating the lock-pit and for the culverts and lock floor (with its proportion of the estimate for contingencies) amounts to $1,010,875, and at least this sum should be appropriated for this purpose for the fiscal year 1888–'89, because the excavation once made the work should be carried forward without interruption to the extent indicated. Any other course will be unwise, and in case the coffer-dam should fail it might prove disastrous; and this sum should be made available at the earliest possible date.

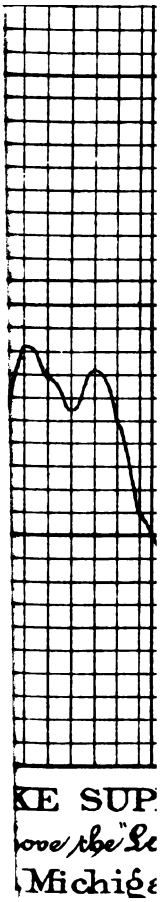
The estimate for the masonry of lock-walls is $980,000, which, with its proportion for contingencies, amounts to $1,225,000. This should be put under contract, in order that the stone may be quarried and worked long enough to properly season before being built into the wall.

The aggregate, then, of the funds which should be made available as soon as practicable is $2,235,875. While any reduction of this amount would be a cause of great regret, yet if it should be deemed necessary to make a reduction the best way to do so would be to omit the $1,226,000 for masonry of lock-walls. On no account should the remainder ($1,010,875) be reduced, nor should the appropriation in this case be trammeled with any condition requiring more than the excavation of the lock-pit and building the culverts and lock floor.

Amount (estimated) required for the enlargement of St. Mary's Falls Canal	$24,738,8
Amount that can be profitably put under contract during the fiscal year ending June 30, 1890	2,235,8

A comparative statement of the amount and value of the commerce through Saint Mary's Falls Canal for the calendar years 1886 and 188 was printed as House Ex. Doc. No. 52, Fiftieth Congress, first sessio A copy is hereto appended, marked A.

An examination was made of the records of the canal office for the season of 1887, and supplemented by correspondence, the object which was to determine the average length of voyage of the vesse using the canal, and the actual freight charge per ton per mile for t cargoes transported. The results were most interesting, and were e bodied in a special report to the Chief of Engineers, dated May 1 1888. A copy of this report, together with a copy of the report of A


KE SUP
ove the "Le
Michiga

ıt Engineer E. S. Wheeler, upon which it is based, is hereto ap-
ɔd, marked B.
a further result of the examination, the following facts were de-
ed, viz:
ɔ total number of registered craft which used the canal during the
n of 1887 was 570, with a registered tonnage of 320,346 and a val-
n of $19,773,950. Of these 498 were American, with a registered
ıge of 290,828 and a valuation of $17,684,550, and 72 were Cana-
with a registered tonnage of 29,518 and a valuation of $2,089,400.
ɔ Canadian craft constituted 12 per cent. of the whole number;
registered tonnage was 9 per cent., their valuation 11 per cent.,
freight tonnage 7 per cent. of the total, and they carried 40 per
of all the passengers.

WATER-LEVEL OBSERVATIONS.

ıter-gauge readings above and below the locks at St. Mary's Falls
l have been made daily. The monthly means of the readings taken
ɔ the locks have been deduced and platted in the usual way.
ɔ monthly mean elevation, in feet, of the surface of Lake Superior
ɔ sea-level, as determined from these observations, was as follows:

Date.	Quantity.	Date.	Quantity.
	Feet.		*Feet.*
887	601.443	December, 1887	601.095
87	601.813	January, 1888	600.945
, 1887	601.696	February, 1888	600.594
ber, 1887	601.555	March, 1888	600.645
, 1887	601.729	April, 1888	600.635
ber, 1887	601.500	May, 1888	601.236

ɔompilation of the foregoing data is shown on the accompanying
ıg.

GENERAL REMARKS.

ring the year an elaborate study of the best plan for gates for the
ɔsed lock has been made, under my direction, by First Lieut. Harry
odges, Corps of Engineers, and to less extent by Assistant Engi-
E. S. Wheeler. Lieutenant Hodges's results are very satisfactory,
eflect great credit upon him, both for his industry and his ability.
ɔf the plans prepared by Mr. Wheeler is entirely his own, and pre-
some remarkable features, which are surely worthy of careful
deration. The most noteworthy characteristic of this plan is the
ɣe in the nature of the stresses from compression to extension.
. E. S. Wheeler, assistant engineer, had local charge of all the
ıeering operations upon St. Mary's River and Canal, and has per-
ɔd his duties to my satisfaction.
sistant Engineer Joseph Ripley has had charge of the surveys and
ɔrepared the plans for the proposed piers in front of Fort Brady
rvation, as well as special reports upon drilling and blasting in the

ıpector R. Common, jr., has had charge of the books and accounts.
ıpector J. L. Callard has had charge of the pier construction.
b-inspector F. H. Reed was continuously employed upon the work
ever his services could be made most useful.

Subinspectors Kallman, Mangelsdorf, Poe, and Reynolds have had charge of the dredging, drilling, and blasting.

During the season of 1887 Patrick Collins and Rupert Rains had charge of the United States drill-scow, and W. W. McNaughton was captain of the United States tug *Myra*. Captain McNaughton resigned at the close of the season, and in April, 1888, Capt. L. E. Sherman was appointed to the vacancy.

This work is in the collection district of Superior, Michigan. Marquette is the nearest port of entry, but Sault Ste Marie is a subport.

The nearest light-houses are the beacons at the western end of St. Mary's Falls Canal. Fort Brady is within half a mile of the canal.

Money statement.

July 1, 1887, amount available		$227,909.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$112,508.72	
July 1, 1888, outstanding liabilities	24,432.48	
July 1, 1888, amount covered by existing contracts	90,968.22	
		227,909.42
Amount appropriated by act of August 11, 1888		1,000,000.00
Amount (estimated) required for completion of existing project		3,738,865.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		2,235,875.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for furnishing supplies for improving St. Mary's River, Michigan, receive and opened October 14, 1887, *in accordance with advertisement dated October* 4, 1887.

No.	Name of bidder.	Residence.	Hardware.*	Ship chandlery.	Remarks.
1	T. B. Rayl & Co	Detroit, Mich	$285.19		Recommended for acceptance.
2	Hodgson & Howard	do	291.04		
1	H. D. Edwards & Co	do		$625.39	Do.

*Approximate total.

NOTE.—No bids were received for lumber and coal.

Abstract of bids for furnishing lumber and coal for improving St. Mary's River, Michigan, received and opened November 25, 1887, *in accordance with advertisement dated November* 10, 1887.

No.	Name of bidder.	Residence.	Lumber.*	Coal.*	Remarks.
1	Johnson & Goss	Sault Ste. Marie, Mich	$420.00		Recommended for acceptance.
2	Charles Hebard & Son	do	525.00		
1	George Kemp	do		$743.00	Do.

*Approximate totals.

Abstract of bids for drilling and blasting at St. Mary's Falls Canal, Michigan, received and opened March 26, 1888, in accordance with advertisement dated February 25, 1888.

No.	Name of bidder.	Residence.	Price per hole for drilling and blasting.		Remarks.
			Where contractor furnishes explosives.	Where United States furnishes explosives.	
1	Hickler & Green.....	Sault Ste. Marie, Mich.	$4.47	$3.00	Recommended for acceptance.
2	Carkon, Stickney & Cram.	East Saginaw, Mich..	5.20	3.75	
3	Ingles & Hillman.....	New York, N. Y.....	25.00	28.00	

A.—COMMERCE PASSING THE SAINT MARY'S FALLS CANAL DURING THE SEASON OF 1887.

WAR DEPARTMENT,
Washington City, December 29, 1887.

The Secretary of War has the honor to transmit to the House of Representatives, for the information of the Committee on Rivers and Harbors, a letter of the 22d instant from the Chief of Engineers, together with a letter from Lieut. Col. O. M. Poe, Corps of Engineers, in regard to the commerce passing the St. Mary's Falls Canal, accompanied with comparative statements, etc.

WM. C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 22, 1887.

SIR: I have the honor to submit the inclosed copy of a report to this office from Lieut. Col. O. M. Poe, Corps of Engineers, dated the 17th instant, in reference to the commerce passing the St. Mary's Falls Canal during the season of 1887, with comparative statements, etc.; and, in view of the importance and magnitude of the interests concerned, to request that it be forwarded to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

LETTER OF LIEUTENANT COLONEL O. M. POE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 17, 1887.

SIR: I beg leave to invite special attention to the report of this date upon the commerce of St. Mary's Fall's Canal, and, in view of the im-

portance and magnitude of the interests involved, respectfully suggest the propriety of transmitting it to Congress, for use in connection with the question of an appropriation for continuing the enlargement of St. Mary's Falls Canal.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT-COLONEL O. M. POE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 17, 1887.

SIR: I have the honor to submit the following report relating to the commerce passing St. Mary's Falls Canal during the season of 1887, just closed, including a comparative statement of the same for the seasons of 1886 and 1887, and an estimate of its value for 1887, based upon the unit prices heretofore used in similar estimates, as affording a better basis for comparing the business than prices amended to conform to those actually prevailing.

The canal was open to navigation two hundred and sixteen days during the season of 1887, the first vessel having passed May 1 and the last one December 2, thus making the season eight days shorter than that of 1886.

It will be observed that the number of passages of all classes exceeds that of preceding season 1,931, or 26 per cent.

The increase in freight tonnage for 1887 was 966,890 tons, or 21 per cent., as against an increase in the registered tonnage of 678,201 tons, or 16 per cent.

The passenger traffic shows an increase of 21 per cent., for which there is no apparent reason other than a legitimate increase in tourist and commercial travel.

All the items enumerated in the statement show a healthy and decided increase, save flour, manufactured and pig iron, copper and silver ore.

The decrease in the flour shipments, amounting to 11 per cent., is undoubtedly due to the scarcity of water for the great mills at Minneapolis and consequent reduction in the output at that point. This decrease in the amount of flour is much more than compensated for, however, by the increase of 22 per cent. in the item of wheat. As the item "manufactured and pig iron" includes iron and steel rails transported to the new railroads of the Northwest, the completion of which reduced the demand for this product, the falling off is easily accounted for.

The decrease in the item of copper and silver ore is due to the decreased facilities for transporting these valuable commodities by rail.

Beginning with August, 1887, a memorandum record was kept of the quantity of wool and hides passing the canal for the remaining four months to the close of the season. This record shows that these items amounted to $1,791\frac{1600}{2000}$ tons and $225\frac{600}{2000}$ tons, respectively.

The item "unclassified freight" amounts to but 6 per cent. of the total freight tonnage.

The number of vessel passages during the three busiest months of the season were as follows:

For month of—	Number.	Average per day.
June	1,685	56.17
July	1,665	53.7
August	1,780	57.42
Total	5,130	

An average of 55.76 per day for ninety-two days.

The corresponding statistics for 1886 were as follows, viz:

For month of—	Number.	Average per day.
June	1,196	39.87
July	1,285	41.77
August	1,250	40.32
Total	3,741	

Or an average of 40.66 per day for ninety-two days.

The rate of increase during 1887 was, therefore, 37½ per cent.

Should the same *rate* of increase be continued for *two* more years we will have reached our estimated ultimate capacity of the present lock, which is ninety-six vessels per day, or one vessel every fifteen minutes during the twenty-four hours.

On one day in the month of June eighty-four vessels were passed through the canal. On the 3d June forty-nine vessels passed the canal, carrying 49,258 tons of freight, or an average of a little more than 1,000 tons per vessel. Over 50,000 tons were passed on one day, but in a greater number of vessels.

Very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

Comparative statement of the amount and value of the commerce through St. Mary's Falls Canal, Michigan, for the calendar years 1886 and 1887.

Items.	Quantity.		Increase.		Decrease.		Price per unit.
	1886.	1887.	Amount.	Per cent.	Amount.	Per cent.	
Vessels ... number	7,424	9,355	1,931	26			
Lockages ... do	3,593	4,165	572	16			
Tonnage, registered ... tons	4,219,397	4,897,598	678,201	16			
Tonnage, freight ... do	4,527,759	5,494,649	966,890	21			
Passengers ... number	27,088	32,668	5,580	21			
Coal ... net tons	1,009,999	1,352,987	342,988	34			$3.50
Flour ... barrels	1,759,365	1,572,735			186,630	11	5.00
Grain ... bushels	19,706,867	23,871,686	4,164,819	21			.98
Manufactured iron ... net tons	115,208	74,919			40,289	35	50.00
Pig-iron ... do							17.00
Salt ... barrels	158,677	204,908	46,231	29			1.00
Copper ... net tons	38,627	34,886			3,741	10	200.00
Iron ore ... do	2,087,809	2,497,713	409,904	20			3.50
Lumber ... feet B. M.	138,688,000	165,226,000	26,538,000	19			.018
Silver ore ... net tons	2,009	350			1,659	83	153.79
Building stone ... do	9,449	13,401	3,952	42			10.00
Unclassified freight ... do	230,726	344,586	113,860	49			60.00

Comparative statement of the amount and value of the commerce through St. Mary's Falls Canal, Michigan, etc.—Continued.

Items.		Total valuation.	
		1886.	1887.
Coal	net tons	$3,534,996.00	$4,735,454.50
Flour	barrels	8,736,825.00	7,863,675.00
Grain	bushels	19,312,720.84	23,394,242.28
Manufactured iron	net tons	5,366,950.00	3,035,750.00
Pig-iron	do	133,773.00	241,468.00
Salt	barrels	158,677.00	204,908.00
Copper	net tons	7,725,400.00	6,977,200.00
Iron ore	do	7,307,331.50	8,741,995.50
Lumber	feet B. M.	2,496,384.00	2,974,068.00
Silver ore	net tons	308,964.11	53,826.50
Building stone	do	94,490.00	134,010.00
Unclassified freight	do	13,843,560.00	20,675,160.00
Total		69,880,071.95	79,031,757.78

Canal was opened to navigation 224 days in 1886.
Canal was opened to navigation 216 days in 1887.
Valuation based on estimate of 1885.
Valuation for 1885, $53,413,472.13.

B.—REPORT OF LIEUTENANT-COLONEL O. M. POE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., May 11, 1888.

SIR: At the close of the season of 1887, Assistant Engineer E. S. Wheeler, in local charge of the works of river improvement at Sault Ste. Marie, and general superintendent of St. Mary's Falls Canal, suggested that the otherwise idle time of the permanent employés at the canal be utilized during the interruption of navigation in an examination of the records of the canal office, with a view to ascertaining from them such information as would, when supplemented by data obtained from those engaged in commerce, show the average length of voyage of the vessel using the canal, and the actual freight charges per ton per mile for the cargoes transported.

The suggestion received my approval, and the work has been assiduously carried on. It involved a great deal of labor, but no expenditure of moment, yet the results obtained are so interesting, important, and satisfactory that a considerable expenditure on this account would have been justifiable.

I transmit herewith a copy of Mr. Wheeler's report, omitting, however, the correspondence had with shippers and carriers, but including the data obtained and condensed from the many letters received.

The gist of the report is contained in the following figures, the ton of 2,000 pounds being used in all cases:

	Tons.
Down freight	3,749,436
Up freight	1,755,213
Total freight	5,494,649
Total mile-tons	4,458,544,804

Average distance each ton was carried by water, 811.4 miles; total freight charges, including terminal charges, $10,075,153.13; average freight charges per ton per mile, .23 of a cent; average freight charges per ton for 811.4 miles, $1.83.

The average charges during the year 1887 upon each of the follow-
g items carried through St. Mary's Falls Canal were as follows:

Articles.	Rate.	Articles.	Rate.
al ..... per ton..	$0.90	Iron ore ..... per ton..	$1.75
ur ..... per barrel..	.29	Lumber ..... per M ft., B. M..	4.00
ain ..... per bushel..	.07	Silver ore ..... per ton..	3.00
nufactured iron ..... per ton .	2.35	Stone ..... do....	1.15
t ..... per barrel..	.18	Unclassified freight ..... do....	4.00
pper ..... per ton..	2.60		

The Bureau of Statistics gives the average freight charges per ton
r mile on the trunk railroads of the United States for the year 1886
.999 of a cent, or, in round numbers, 1 cent.
Thus the average freight charges by rail compared with those by
ater appear to be as 811 to 183. That is to say, rail transportation
r freight costs 4.43 times as much as by this water route.
Upon this basis the $10,075,153 representing the cost of freight
ansportation by this water route during the season of 1887 would
ave been, if the freight had been carried by rail, $44,632,293, and the
ving, because of the availability of the water route, amounts to no
ss a sum than $34,557,140 for the single season.
But it is well known that the freight rates by such railroads as com-
ete with water routes are always reduced during the season of naviga-
on. If the water route were not available it is to be presumed that
e rates would be maintained at a considerably higher average for the
ar than that mentioned above, and the sum actually saved in trans-
ortation, due to the existence of the water route under consideration,
ight therefore to be correspondingly increased.
It is not at all improbable that but for the water route open for about
ven months in 1887 the charges levied upon the freight carried would
ave amounted to $50,000,000. If this estimate is not exaggerated, and
think it is not, then the actual benefit to producer and consumer was
lly $40,000,000 in that single year, divided between them in unknown
oportions.
To realize what this benefit means it is only necessary to state that
represents more than ten times the cost of improving the canal and
. Mary's River to the present time, or about six times the estimated
ost of the proposed further improvement, or about four times the cost
all the improvements already made and those yet to be made between
ake Superior and Lake Huron.
Moreover, it is fully seven times the amount expended upon improve-
ents between Lake Superior and Lake Erie.

Very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. E. S. WHEELER, GENERAL SUPERINTENDENT.

SAULT STE. MARIE, MICH., *April* 19, 1888.

COLONEL: I have the honor to make the following report upon the average cost
er mile per ton of freight carried through St. Mary's Falls Canal, Michigan, during

season of 1887. This quantity is equal to the total cost of transporting the freight divided by the total number of mile-tons. The work is therefore divided into two parts; the first is to find the total number of mile-tons; the second is to determine the total cost of transportation. For the first part the data contained in this office is sufficient. The reductions were made as follows: Tables were prepared in which the name of each boat passing through the canal was entered in the first column. The ports between which it sailed was entered in the second column, the distance in miles between the given ports in the third column, and the freight tonnage in the fourth column. The distances used were the shortest sailing distances between the ports named. To obtain these a table of distances was carefully prepared from the Lake Survey charts. The number of miles and the number of tons were then multiplied together and entered in the fifth column, which was called mile-tons. This column was afterwards summed, which gave the total mile-tons for the season of 1887.

The multiplications and additions were carefully checked. This table contains 535 pages. Its preparation has been under the direction of Mr. Andrew Jackson, clerk, aided by the assistant superintendents, Charles A. McCarthy and Reuben Smith.

The total number of mile-tons is 4,458,544,804. Since the total number of tons is 5,494,649, the former divided by the latter gives 811.4 miles for the average distance that the freight which passed St. Mary's Falls Canal in 1887 was carried by water. The amount of this work may perhaps be more readily grasped if expressed in other units.

The following comparisons with railroads and teams have therefore been made. If this work should be done by a railroad 811.4 miles long it would require twice as many trains as would be necessary to move the down freight. The down freight is 3,749,436 tons, or a little more than two-thirds of the total freight.

Assuming that each car carries 10 tons, and that there are 30 cars in a train, and the average speed of a train is 15 miles per hour for the twenty-four hours of each day, and that the trains run 365 days in the year, it would require 175 trains to do the work, or an average of 35 trains daily each way. Again, if this work should be done by teams, assuming that each team moved 1 ton 20 miles a day for six days in the week, it would require 972,028 teams, or 23,958 daily. If 31 feet space be allowed each team it would make a continuous procession, seven abreast, moving at 2 miles an hour for ten hours of each working day in the year.

The second part of the work consists in determining the total amount paid for the water transportation of the freight which passed through St. Mary's Falls Canal during the season of 1887. The data for this is not kept in this office. It was obtained by correspondence with shippers and carriers.

Rates on anthracite coal.

Date.	Destination.	Freight, (net tons.)	Date.	Destination.	Freight, (net tons).
June 7	Marquette	$0.80	Aug. 24	Marquette	$1.00
20	do		24	do	1.00
July 18	do	1.00	Sept. 1	Lake Linden	1.25
18	do	1.00	1	Houghton	1.25
19	Hancock	1.05	6	Hancock	1.25
23	Marquette	1.00	7	Lake Linden	1.25
23	Hancock	1.05	8	Hancock	1.25
23	do	1.05	8	Houghton	1.25
25	Lake Linden	1.05	8	Marquette	1.00
25	Hancock	1.05	15	Lake Linden	1.25
29	Lake Linden	1.05	19	Marquette	1.25
30	Hancock	1.05	19	Houghton	1.25
30	Houghton	1.05	Oct. 7	Marquette	1.25
Aug. 6	Marquette	1.00	17	do	1.25
11	do	1.00	26	do	1.25
13	Houghton	1.05	27	do	1.25
17	Marquette	1.05	Nov. 7	do	1.25
24	do	1.00			

ontained in letters from shippers and carriers has been collected and con-
is given in the following table:

GRAIN.		
Co	Duluth and Washburn to Buffalo	$0.06½
	Port Arthur to Kingston, Ontario (Canadian tonnage, about).	.07½
n	Duluth and Washburn to Buffalo	.06½
Transportation Company	Duluth to Buffalo	.05 to .06½
ary	Duluth and Washburn to Buffalo	.0584
and Lake Superior Transporta-y.	Chicago to Lake Superior, per hundred.	.18
	(Adopted mean)	.07 ± .004
SALT.		
Transportation Company, Man-	Average rate	.06 ± .0
COAL.		
Co	May to October	.85
	October and November	1.00
n	Average for season	.85
ary	do	.76½
Co	Average from July to November (anthracite).	1.00
	Adopted mean	.90 ± .05
NERAL MERCHANDISE.		
Transportation Company	Average	.28½
	Average, verbal information	.15
"L. & A"	do	.17.5
	do	.05
	Adopted mean	.20 ± .03
BUILDING STONE.		
Co		1.15 ± .06
COPPER.		
Transportation Company, Man-	Lake Superior to lower points, per hundred.	.13 ± .0
IRON ORE.		
.P. Ely	Two Harbors to Lake Erie, gross ton	1.95
	To Chicago, gross ton	2.25
	To Buffalo, gross ton	2.50
n	From Ashland to Ohio	2.10
	From Marquette	1.85
	From Two Harbors	1.90
Co	May to October	2.00
	October and November (only 2,922 tons).	2.75
Co	From Ashland	2.10
	From Two Harbors	2.10 to 2.15
	Adopted mean	2.10 ± .05
FLOUR.		
ary	Duluth and Washburn to Buffalo, per hundred.	.08
Transportation Company, Man-	do	.15
	Duluth and Washburn to Buffalo, per barrel.	.30
	Adopted mean	.14½ ± .015
ANUFACTURED IRON.		
n*	Lake Erie ports to Duluth, per ton	2.25
		2.35 ± .12
LUMBER.		
per Company	To Chicago ... per M	3.50 to 3.75
	To Buffalo ... do	4.25 to 4.50
	To Cleveland ... do	4.25 to 4.50
	To Toledo ... do	4.00 to 4.25
	To Tonawanda, average	2.41½
	To Ogdensburgh, average	3.87½
and Lake Superior Transporta-y, Chicago Line.	To Chicago	3.50
	Adopted mean	4.00 ± .28

ate is principally for railroad iron; other manufactured iron generally costs more. The
herefore been increased to $2.35, adopted mean.

An average rate for each commodity has been assumed from an inspection of the table. This part of the work is to a limited extent arbitrary, and it is not likely that any two persons would arrive at precisely the same results. Mr. Andrew Jackson and myself made separate estimates. Our results did not differ much in any case. After further discussion, one or the other value or a mean was accepted. It may at first seem that where such methods are unavoidable but little confidence should be attached to the results, but an inspection of the table will show that the uncertain limits are very small, and that our judgments could not be very far wrong. In order to show what confidence may be had in the results, an estimate has been made of the possible error in the adopted average rate for each commodity. Thus, for coal, an inspection of the table shows that it is almost certain that the average rate did not exceed 95 cents nor fall below 85 cents per ton; therefore the possible error in this case has been taken as 5 cents per ton. All of the other commodities have been treated in a similar way, the greatest uncertainty being in the item "unclassified freight." The items "salt," "copper," and "silver" all have an invariable rate, and therefore no uncertainty. After computing and reducing these possible errors in the usual manner, it was found that the possible error of the final result was less than 3 per cent. It will be observed that the data in regard to flour is the most defective of any. This is probably due to the fact that much of it was carried in connection with railroads, and any division of the cost would be, to a certain extent, arbitrary. A possible error of about 10 per cent. has, therefore, been assigned to this item. After the average rates had been adopted the following table was formed, from which was obtained the total amount paid for the transportation of the freight which passed through St. Mary's Falls Canal during the season of 1887:

[In this table tons mean net tons or 2,000 pounds.]

Item.	Quantity.	Price per unit.	Amount.
Coal ..... tons..	1,352,387	$0.90 ± .05	$1,217,688.30 ± $67,649.35
Flour ..... barrels..	1,572,735	0.29 ± .03	456,093.15 ± 47,182.05
Grain ..... bushels..	23,871,689	0.07 ± .004	1,671,018.09 ± 95,486.75
Iron, manufactured ..... tons..	74,919	2.35 ± .12	176,059.65 ± 8,990.28
Salt ..... barrels..	204,908	0.18 ± .00	36,883.44 ± 0.00
Copper ..... tons..	34,886	2.60 ± .00	90,703.60 ± 0.00
Iron ore ..... do...	2,497,713	1.75 ± .05	4,370,997.75 ± 124,885.65
Lumber ..... M ft., B. M..	165,226	4.00 ± .28	660,904.00 ± 46,263.28
Silver ore ..... tons..	350	3.00 ± .00	1,050.00 ± 0.00
Stone ..... do...	13,401	1.15 ± .06	15,411.15 ± 804.06
Unclassified freight ..... do...	344,526	4.00 ± .60	1,378,344.00 ± 206,751.60
Total	.....	.....	10,075,153.13 ± 276,559.00

The possible error assigned to the total in the preceding table is the square root of the sum of the squares of the possible errors of the separate items, and is 2.7 per cent. of the total. Therefore all results based upon this table may be considered certainly accurate within 3 per cent. The total cost being $10,075,153.13 and the total number of mile-tons being 4,458,544,804. If the former be divided by the latter the cost per mile per ton is obtained, equal to 23 cents.

The nature of the data from which this value is obtained is such that it includes the cost of loading and unloading. The actual cost of moving 1 ton 1 mile in the open water-way would be something less.

In 1882 General Weitzel made an estimate of the cost per mile per ton based upon the rates paid for carrying iron ore and obtained a result equal to 28 cents.

The Bureau of Statistics gives the average freight charges per ton on the trunk railroads of the United States for the year 1886 as 0.999 cents. If the total cost of transportation by water during season of 1887 be divided by the number of tons carried, the average cost per ton for 811.4 miles is found to be $1.83 as against $8.11 by rail.

The following is a summary of the principal results obtained: Total mile-tons, 4,458,544,804; total amount paid for transportation by water of all freight which passed St. Mary's Falls Canal during the season of 1887, $10,075,153.13; average freight charges per ton per mile on all freight which passed St. Mary's Falls Canal during the year 1887 equal to 23 cents; average distance by water, 811.4 miles; down freight, 3,749,436 tons; up freight, 1,745,313 tons.

Average freight charges during the year 1887 on each of the following items carried through St. Mary's Falls Canal.

Articles.	Amount.	Articles.	Amount.
Coal ..... per ton..	$0.80	Lumber ..... per M..	$4.00
Flour ..... per barrel..	.29	Silver ore ..... per ton..	3.00
Grain ..... per bushel..	.07	Stone ..... do....	1.15
Iron, manufactured ..... per ton..	2.35	Unclassified freight ..... do....	4.00
Salt ..... per barrel..	.18		
Copper ..... per ton..	2.60	Average of all freight, per ton....	1.83
Iron ore ..... do....	1.75		

Respectfully submitted.

E. S. WHEELER,
General Superintendent.

Lieut. Col. O. M. POE,
Corps of Engineers, U. S. A.

J J 2.

OPERATING AND CARE OF SAINT MARY'S FALLS CANAL, MICHIGAN.

Saint Mary's Falls Canal, about 1 mile in length, constitutes a part of the water-route between Lakes Huron and Superior, and affords a means of passing the Sault de Ste. Marie, overcoming by its lockage system a difference of level of about 18 feet.

The prism is of variable width, and has a depth of 16 feet at the ordinary stage of water.

Soon after the beginning of the fiscal year the double-lockage system, existing at the date of the last Annual Report, was destroyed by the operations connected with the construction of a coffer-dam to inclose the site of the new lock under the project for the enlargement of the canal, which required the removal of the lower end of the south wall of the old locks (of 1855), together with the south leaf of the lower lock-gate. Consequently the commerce of this important water-route is now entirely dependent upon the single lock of 1881.

The old locks (of 1855) are to be replaced by a single lock 800 feet long between gates, uniformly 100 feet wide, with 21 feet of water on the miter-sills and having a lift of something less than 18 feet, the full descent of Saint Mary's Falls.

The new lock (of 1881) is 80 feet wide, narrowing to 60 feet at the gates, 515 feet between gates, with 17 feet of water on the miter-sills, and overcomes the difference of level by a single lift. It is an admirable structure, and perfectly serves its purpose. Its operation is so rapid, quiet, and efficient that our experience during the seven years it has been in use only proves the great care with which all the details of the construction were studied and the thoroughness with which they were executed.

CONTRACTS.

The following is a list of contracts in force at some time during the fiscal year, and the present condition of each:

With Hickler & Green, dated June 27, 1887, for machine work; still in force.
With T. B. Rayl & Co., dated October 19, 1887, for hardware; completed.
With Johnson & Goss, dated October 19, 1887, for lumber, shingles, and lime; completed.

With Wells W. Leggett, dated October 26, 1887, for electric-light supplies; completed.
With W. D. Edwards & Co., dated October 26, 1887, for ship-chandlery, etc.; completed.
With James E. Davis & Co., dated October 26, 1887, for paints, oils, etc.; completed.
With the Richmond & Backus Company, dated January 3, 1888, for stationery; completed.
With William R. Santley, dated February 27, 1888, for white oak timber; still in force.
With Burnett & Strachan, dated March 19, 1888, for one oil tank; completed.
With Hickler & Green, dated March 19, 1888, for castings, etc.; completed.

The contract dated February 17, 1887, with Westervelt & Dennis, for furnishing timber for one set of lower gates for the lock of 1881, to which reference was made in the last Annual Report, terminated on the 30th of June, 1887, by its own limitation, after the greater part of the pine sheathing had been delivered. They expressed a willingness, however, to furnish the remainder of the timber later, and it was agreed that if they did so it would be purchased at the contract prices. None was delivered under this agreement, and one member of the firm having subsequently committed suicide, the other gave formal notice of his inability to deliver any timber.

New proposals were then invited, and on the 27th February, 1888, a contract was entered into with William R. Santley, under which he agreed to deliver the required oak timber at the canal on or before June 30, 1888, but afterwards asked that the date of delivery be extended ninety days. The reasons assigned were considered of sufficient weight and, by authority of the Chief of Engineers, the contract was extended as requested.

No timber has yet been delivered, but it is hoped that the contract will be duly completed, as extended, and that after nearly eighteen months of earnest effort we may succeed in obtaining this material, which is so essential.

ORGANIZATION.

The organization of the regular lock force has been increased since the date of the last Annual Report by 1 watchman. It now consists of 1 superintendent, 2 assistant superintendents, 1 clerk, 2 enginemen, 2 foremen, 5 watchmen, and 15 lockmen. There has been but little change in the personnel.

A small labor party of variable strength is employed to make current repairs to buildings and piers, in policing the grounds, and in doing any other work that may be required of them. This party is under the immediate charge of a third foreman.

ACCIDENTS AND DELAYS.

On the 16th September, 1887, the cable which opens the south half of the lower gates of the lock broke at 10.30 a. m. Three hours and five minutes were occupied in replacing it. On the 23d of the same month, at 2.25 a. m., the same cable again parted, and six hours and forty-five minutes were occupied in replacing it. The latter break was caused by the cable running out of the sheave. On each occasion several vessels were delayed.

On October 16, 1887, the lock was closed for six hours to tighten the stuffing-boxes of the valve engines before putting in the oil for cold weather use.

June 2, 1888, the steam barge *Fred Mercur* ran into the northwestern pier opposite the range light and crushed in the outer face of the pier.

CARE OF PROPERTY AND GROUNDS.

After the close of navigation for the season of 1887 the valve engines were taken out, and during the winter new piston-rods were made and the engines thoroughly repaired.

Upon an examination of the emptying-valve frames it was found that the bottom piece of each was broken near the corners. The broken pieces were replaced and bolted to the floor of the lock. The axes of all the valves were found considerably worn, and all the valve seats were bushed. All of the rest of the lock machinery received the usual overhauling, repairs, cleaning, and painting.

An iron tank, with a capacity of 625 gallons, has been built to hold the oil which is used in the hydraulic engines and pipes during cold weather.

Both lock culverts were inspected throughout their whole length. They were found in perfect condition, and the deposit of silt at the lower end was less than at the time of the previous examination, amounting to only a few cubic yards.

During the year 350 small shade trees were planted on the canal grounds. The walks have been repaired, and the buildings and fences painted and whitewashed.

MOVABLE DAM.

The movable dam was closed once each month during the season of navigation. This work was usually done at night, after vessels had ceased to arrive.

The dam itself has been kept in complete order, but, owing to the blasting and dredging going on just above, it has not been possible to keep the sill clear from earth and stones.

DIVING CREW.

The diving crew was employed on an average two or three times a month in making repairs and examinations. During most of the season there was no other diving apparatus at Sault Ste. Marie, and, under exceptional conditions, its use for making examinations of injury to vessels was permitted, subject to such regulations as would prevent abuse of the privilege. There is now a complete private wrecking outfit kept at the place, and the use of the Government diving apparatus in connection with injured vessels will be no longer necessary.

REBUILDING PIER SUPERSTRUCTURE.

Six hundred and fifty feet of superstructure on the south side of the canal has been rebuilt. The timber for this work was purchased from C. E. Mitchell at his contract price for such timber furnished by him for the coffer-dam cribs. The average cost of the 9,777 cubic feet used was 20¼ cents per cubic foot.

During July, 1887, The Sault Ste. Marie Bridge Company commenced the construction of a railroad bridge across the river and canal, under authority of the act of Congress approved July 8, 1882. To facilitate their operations they were allowed, by authority of the Secretary of War, to use about 400 feet of the northwest pier of the canal for the purpose of landing materials. The fixed portion of the bridge

was first completed. The draw-span over the canal was erected after the close of navigation, and the bridge is now in use. So far as the interests of the Government are concerned the bridge company complied with every provision of the law. They asked no privilege which it was improper to grant, and promptly conformed to every requirement made of them.

REMOVAL OF SPOIL BANKS.

It has always been deemed desirable to secure the removal of the old spoil banks, which so marred the appearance of the canal, provided it could be done without cost to the United States. Accordingly all persons have been encouraged to take as much of this waste material as possible, the only condition imposed being that the grade be left such as the canal authorities might indicate. Under this general permission, given specifically to them, however, the bridge company and the Duluth, South Shore and Atlantic Railway Company have removed all of the spoil banks west of the movable dam, thus greatly improving the appearance of the canal grounds.

ESTIMATES.

The estimated cost of operating and care during the fiscal year ending June 30, 1888, was $31,000. The expenditures in gross amounted to $29,898.72. From this should be deducted the sum of $844, received for dry-docking, leaving $29,054.72 as the net cost of operating and care for the fiscal year.

The project for operating and care of the canal for the fiscal year ending June 30, 1889, contemplates maintaining the present organization; purchasing the requisite supplies; moving any buildings belonging to the canal that may stand in the way of the work in progress in connection with the construction of the proposed new lock; purchasing, by contract, the timber required for one set of lower gates for the lock of 1881; building a rough shed to cover this timber from the weather; probably constructing the gates; employing such labor as may be required in making current repairs and policing the canal grounds.

The estimated cost of the foregoing is as follows, viz:

For pay of regular lock force	$19,000
For pay of labor party	6,000
For general purchases	5,000
For timber for one set of lower lock-gates	3,000
Total	36,000

No estimate is included for extraordinary repairs which may be rendered necessary by accident. Such can not be foreseen and therefore can not be estimated for.

In case of injury or damage to the canal beyond that due to ordinary wear and tear, it must be promptly made good at whatever cost.

All expenses of operating and care are provided for by indefinite appropriation under section 4 of the river and harbor act approved July 5, 1884.

Statement of the business of St. Mary's Falls Canal, Michigan, for the fiscal year ending June 30, 1888.

Number and class of vessels passed:	
Side-wheel steamers	41
Screw steamers	5,635
Sail-vessels	2,330
Rafts and unregistered craft	817
Total passages	8,823
Freight and passenger traffic:	
Coal ... net tons	1,605,279
Copper ... do	31,868
Flour ... barrels	1,645,236
Wheat ... bushels	22,027,169
Grain, other than wheat ... do	1,022,252
Iron ore ... net tons	2,328,275
Pig and manufactured iron ... do	63,571
Freight and passenger traffic—Continued:	
Salt ... barrels	201,922
Silver ore ... net tons	1,168
Lumber ... feet, B. M.	188,228,000
Building stone ... net tons	20,404
Miscellaneous and unclassified, including 2,214$\frac{1000}{2000}$ tons of wool and 310$\frac{800}{2000}$ tons of hides, net tons	349,800
Number of passengers	29,494
Total registered tonnage	4,471,976
Total freight tonnage	5,581,169
Total registered tonnage since opening the canal in 1855	42,426,778

Statement of receipts and expenditures at St. Mary's Falls Canal, Michigan, during the fiscal year ending June 30, 1888.

Receipts.		Expenditures.	
Source.	Amount.	For what purpose.	Amount.
Dry-docking	$844.00	Office expenses	$1,296.90
		General purchases	3,142.83
		Repairs	5,796.08
		Labor (operating and care)	18,057.21
		Extra labor	1,244.07
		Light on lock	361.63
	844.00		29,898.72
Net cost of operating and care of canal			29,054.72

Statement of the number of vessels passed through St. Mary's Falls Canal, Michigan, with number of times and cost of lockages for the fiscal year ending June 30, 1888.

Number of vessels	8,823	Total time spent by vessels in the locks	4 894^h 16^m
Number of lockages	3,940	Average time spent by vessels in passing locks	39^m
Registered tonnage	4,741,976	Cost per lockage	$7.37
Freight tonnage	5,581,169	Cost per vessel	$3.29
Total time during which locks were operated	2,559^h 35^m	Cost per ton registered	0.00\frac{61}{100}$
Average time occupied in making a lockage	39^m	Cost per ton freight	0.00\frac{82}{100}$

NOTE.—Cost includes all repairs and improvements made by the operating and care of force and labor party and purchases therefor.

During the fiscal year the canal was open to navigation two hundred and ten days, or eight days less than in the fiscal year 1886–'87. It was closed for the winter on December 2, 1887, and opened May 7 for the season of 1888.

The total amount of registered tonnage through the canal in the thirty-three years from its opening in 1855 to June 30, 1888, was 42,426,778 tons. Of this aggregate, 22,474,291 tons, or more than one-half, has passed since the opening of the new lock, September 1, 1881, a period of less than seven years. The freight tonnage during the latter period was 23,329,070 tons.

During the month of June, 1888, the amount of freight passed through the canal was 1,023,315, which was 69,394 tons greater than the tonnage of any other month in its history.

The statement of passages and lockages during the fiscal year shows an increase of 897 in the former and 248 in the latter.

The statement also shows an increase of 353,285 in the registered tonnage and 698,367 tons freight over the commerce of the preceding fiscal year.

The increase in operating expenses over the preceding fiscal year was $7,367.80. This is accounted for by the purchase of material and rebuilding of 650 linear feet of the superstructure of the pier on the south side of the canal, the employment of an additional foreman and office watchman, at a compensation of $75 per month each, the employment of the entire regular lock force for an additional month, the renewal of portions of the operating machinery, and the complete repair of the remainder.

Money statement.

Amount required for fiscal year ending June 30, 1889	$36,000.00
Balance remaining in hand from allotment of preceding year, exclusive of outstanding liabilities	1,101.28
Additional allotment required for fiscal year ending June 30 1889	34,898.72

Abstract of bids for furnishing supplies of operating and care of St. Mary's Falls Canal, Mich., received and opened October 8, 1887, in accordance with advertisement dated September 28, 1887.

No. of bids.	Name and residence of bidder.	Item.	Amount.	Remarks.
1	T. B. Rayl & Co., Detroit, Mich.	Hardware	$436.86	Recommended for acceptance.
2	Hodgson & Howard, Detroit, Mich.	do	464.60	
3	P. M. Church & Co., Sault Ste. Marie, Mich.	do	393.13	
1	H. D. Edwards & Co., Detroit, Mich.	Ship chandlery and divers supplies.	1,670.65	Do.
2	P. M. Church & Co., Sault Ste. Marie, Mich.	do	1,396.24	
1	James E. Davis & Co., Detroit, Mich.	Paints, oils, etc	638.97 658.97 678.97	Recommended for acceptance such one of the three which included the grade of oil which may be required.
1	Wells W. Leggett, agent, Detroit, Mich.	Electric light supplies.	794.13	Recommended for acceptance.
1	Johnson & Goss, Sault Ste. Marie, Mich.	Lumber and lime	557.25	Do.
2	Charles Hebard & Son, Sault Ste. Marie, Mich.	do	677.25	Incomplete; no bid on lime.
3	John Spry Lumber Company, Sault Ste. Marie, Mich.	do	690.00	Do.
4	George Kemp, Sault Ste. Marie, Mich.	do	17.25	Incomplete; no bid on lumber.
1	do	Coal	360.00	Recommended for acceptance.

NOTES.—The bid of P. M. Church & Co., for hardware, gives no figures on 3 nuts for guard-gate valves, 2 wire screens, 2 dozen iron screws, which, at the figures given by T. B. Rayl & Co., the lowest bidders, amounts to $66.45, making the complete bid $459.58. The bid of P. M. Church & Co., for ship chandlery gives no figures on 2,000 feet wire rope, which, at the figures given by H. D. Edwards & Co., amounts to $320, making the complete bid $1,716.24.

Abstract of bids for furnishing stationery for operating and care of St. Mary's Falls Canal, Mich., received and opened December 22, 1887, in accordance with advertisement dated December 3, 1887.

No.	Name and residence of bidder.	Approximate total.	Remarks.
1	The Richmond and Backus Company, Detroit, Mich.	$318.64	Recommended for acceptance.

tract of bids for furnishing white-oak lumber for lock-gates at St. Mary's Falls Canal, [ich., received and opened on February 18, 1888, *in accordance with advertisement dated* 19, 1888.

	Name and residence of bidder.	White oak, price per 1,000 feet B. M.	Remarks.
1	William R. Santley, Wellington, Ohio	$54.00	Recommended for acceptance.
2	Thomas R. Forsyth, Detroit, Mich	75.75	
3	C. J. Lloyd, Detroit, Mich	79.50	
4	William T. Casgrain, Milwaukee, Wis	88.00	

tract of bids for one oil tank, steel and castings for operating and care of St. Mary's alls Canal, Mich., received and opened March 5, 1888, *in accordance with advertise-ent dated February* 23, 1888.

Name and residence of bidder.	One oil tank, total.	Steel and brass and iron castings, approximate total.	Remarks.
Burnett & Strachan, Sault Ste. Marie, Mich	$147	.....	Recommended for acceptance.
Hickler & Green, Sault Ste. Marie, Mich	325	$216	Steel and castings, recommended for acceptance.

ized statement of expenditures incurred on account of appropriation for operating and re of canals and other works of navigation, as applied to operating and care of St. [ary's Falls Canal, Mich., for the fiscal year ending June 30, 1888.

FOR PART OF THE MONTH OF JULY, 1887.

ate.	No. of voucher.	From whom purchased.	Articles.	Total.
87. 8 1	5	C. Corbett, manager Western Union Telegraph Company.	Transmission of telegrams from and to Washington.	$0.45

FOR MONTH OF AUGUST, 1887.

g. 4	1 and 2	Pay-rolls, July	1 superintendent	150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			3 foremen, 2 months and 18 days, at $75 each.	195.00
			2 watchmen, at $50 each	100.00
			2 watchmen, at $45 each	90.00
			2 lockmen, at $60 each	120.00
			2 lockmen, 1 month and 29½ days, at $50 each.	99.17
			11 lockmen, 10 months and 28½ days, at $45 each.	492.75
			1 carpenter, 260 hours, at 25 cents per hour.	65.00
			1 tinner, 32 hours, at 25 cents per hour	8.00
			1 scrubber, 65 hours, at 15 cents per hour	9.75
			13 laborers, 2,722 hours, at 17½ cents per hour.	476.43

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF SEPTEMBER, 1887.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1887. Sept. 5	1, 2, and 3	Pay-rolls, August	1 superintendent	$150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			2 foremen, 1 month and 21 days, at $75 each.	128.75
			1 watchman, 29 days, at $75	72.50
			2 watchmen, 1 month and 29 days, at $50 each.	98.33
			2 watchmen, 2 months, at $45 each	90.00
			2 lockmen, 1 month and 20 days, at $60 each.	100.00
			2 lockmen, 2 months, at $50 each	100.00
			11 lockmen, 10 months and 18 days, at $45 each.	477.00
			1 carpenter, 260 hours, at 25 cents per hour.	65.00
			1 foreman	75.00
			1 scrubber, 80 hours, at 15 cents per hour.	12.00
			14 laborers, 2,664 hours, at 17½ cents per hour.	466.17
Aug. 1	4	John Hickler	5 hours' work with steam-hammer, at 75 cents per hour.	3.75
8		do	2½ hours' work with lathe, at 60 cents per hour.	1.50
19		do	3 hours' work with steam-hammer, at 75 cents per hour.	2.25
27		do	5 hours' work with steam-hammer, at 75 cents per hour.	3.75
Sept. 30	5	George H. Smith	Rent of one storage room in Detroit, Mich., from July 1 to September 30, 1887, both days included, being three months, at $100 per year.	25.00

FOR MONTH OF OCTOBER, 1887.

Oct. 7	1, 2 and 3	Pay-rolls, September	1 superintendent	150
			2 assistant superintendents, at $100 each	200
			1 clerk	150
			1 engineman	90
			1 engineman	80
			2 foremen, at $75 each	150
			1 watchman	75
			2 watchmen, 1 month and 29 days, at $50 each.	98
			2 watchmen, at $45 each	90
			2 lockmen, at $60 each	120
			2 lockmen, 1 month and 10½ days, at $50 each.	67
			11 lockmen, 10 months and 12½ days, at $45 each.	468
			1 carpenter, 212½ hours, at 25 cents per hour.	53
			1 scrubber, 85 hours, at 15 cents per hour.	12
			2 laborers, 13 hours' at 25 cents per hour.	3
			11 laborers, 2,087½ hours, at 17½ cents per hour.	365
Sept. 24	4	John Hickler	17 hours' work with steam-hammer, at 75 cents per hour.	12
26		do	1⅛ hours work with drill, at 60 cents per hour.	

tized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF NOVEMBER, 1887.

ıte.	No. of voucher.	From whom purchased.	Articles.	Total.
37.				
. 4	1 and 2	Pay-rolls, October.....	1 superintendent.....	$150.00
			2 assistant superintendents, at $100 each.	200.00
			1 clerk.....	150.00
			1 engineman.....	90.00
			1 engineman, 29½ days, at $80 per month ..	78.67
			1 foreman.....	75.00
			1 watchman.....	75.00
			2 watchmen, at $50 each.....	100.00
			2 watchmen, at $45 each.....	90.00
			2 lockmen, at $60 each.....	120.00
			2 lockmen, 1 month and 5½ days, at $50 each.	59.17
			11 lockmen, 16 months and 23½ days, at $45 each.	485.25
			1 foreman.....	$75.00
			2 divers, 3 days, at $7.50 per day.....	22.50
			1 carpenter, 190 hours, at 25 cents per hour.	47.50
			1 scrubber, 75 hours, at 15 cents per hour.	11.25
			1 laborer, 25½ hours, at 25 cents per hour.	6.37
			9 laborers, 978½ hours, at 17½ cents per hour.	171.22
. 1	3	Chauncey E. Mitchell	112,944 feet, B. M., pine lumber, at $17 per M.	1,920.05
			4,032 feet, B. M., hemlock lumber, at $13.25 per M.	53.42
			342 feet, B. M., pine lumber, at $16 per M.	5.47
. 16	4	E. H. Moreton	Cartage of 1 box of hardware from steamer dock to office of superintending engineer, Detroit, Mich.	.25
. 28	5	F. Fayram, secretary and treasurer The Detroit Free Press Company.	Advertising for proposals for supplies...	4.80
3	6	John Hickler	6 hours' lathe work, at 60 cents per hour.	3.60
8	.....	.....do	1 hour's work with steam-hammer.....	.75
29	.....	.....do	7½ hours' lathe work, at 60 cents per hour.	4.50
[illegible]			½ hour's work with steam hammer, at 75 cents per hour.	.37
[illegible]	7	J. T. Whiting, agent	Transporting from Sault Ste. Marie, Mich., to Detroit, Mich., 1 box hardware weighing 100 pounds.	.35
[illegible]	8	O. M. Poe, lieutenant-colonel of Engineers.	Mileage from Detroit, Mich., to Sault Ste. Marie, Mich., and return, being 686 miles, at 8 cents per mile.	54.88
[illegible]	[illegible]	D. W. Bro[illegible]ry Democrat[illegible]g Company.	Advertising for proposals for supplies...	1.95
[illegible]	[illegible]	[illegible]ames E. D[illegible]	50 pounds alabastine, light green, at 6½ cents per pound.	3.25
[illegible]	[illegible]	[illegible]	64 pounds black, lamp, at 9½ cents per pound.	6.08
[illegible]	[illegible]	[illegible]	5 pounds blue, ultramarine, at 17 cents per pound.	.85
[illegible]	[illegible]	[illegible]	[illegible]5 pounds brown, Spanish, at 7 cents per pound.	.35
[illegible]	[illegible]	[illegible]	[illegible] dozen brushes, paint, No. 8 Rd	17.00
[illegible]	[illegible]	[illegible]	[illegible]dozen brushes, striping, No. 5	.10
[illegible]	[illegible]	[illegible]	[illegible]ozen brushes, sash, No. 5	.80
[illegible]	[illegible]	[illegible]	[illegible]dozen bricks, bath, at 75 cents per [illegible]ozen.	.38
[illegible]	[illegible]	[illegible]	[illegible]oes chimneys, lamp	5.00
[illegible]	[illegible]	[illegible]	[illegible]ounds of glue, white, at 25 cents per [illegible]und.	2.50
[illegible]	[illegible]	[illegible]	[illegible]unds green, chrome, at 10½ cents per [illegible]nd.	2.62
[illegible]	[illegible]	[illegible]	[illegible]n globes, lantern, at 75 cents per [illegible]n.	1.50
[illegible]	[illegible]	[illegible]	[illegible]unds lead, white, first quality, at [illegible]ts per pound.	107.50
[illegible]	[illegible]	[illegible]	[illegible]anterns	6.00
[illegible]	[illegible]	[illegible]	[illegible]lons oil, linseed, raw, at 40 cents [illegible]lon.	40.91
[illegible]	[illegible]	[illegible]	[illegible]s oil, linseed, boiled, at 43 cents [illegible]on.	42.71
[illegible]	[illegible]	[illegible]	[illegible] oil, kerosene, at 10 cents per [illegible]	25.[illegible]
[illegible]	[illegible]	[illegible]	[illegible] oil, castor, at 17½ cents per [illegible]	[illegible]

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF NOVEMBER, 1887—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1887. Nov. 16	10	James E. Davis & Co	100½ gallons oil, lard, winter strained, at 58 cents per gallon.	$58.29
			2,000 gallons oil, West Virginia lubricating, 29° gravity, at 10 cents per gallon.	200.00
			25 gallons oil, sperm, at 90 cents per gallon.	22.50
			1 quart oil, sperm, extra quality	1.00
			100 pounds putty, at 2½ cents per pound	2.50
			1 dozen sponges, carriage	3.00
			25 pounds sal soda, at 1½ cents per pound	.37
			3 gallons tar, pine, at 32 cents per gallon	.96
			10 gallons turpentine, pure, at 52 cents per gallon.	5.20
			10 gallons varnish, at $1.35 per gallon	13.50
			10 pounds vermilion, dry, at 12 cents per pound.	1.20
			10 pounds wicks, at 22 cents per pound	2.20
			1 gross wicks, lamp	1.25
			15 yards wicks, a 3 cents per yard	.45
			5 pounds yellow, French, at 7 cents per pound.	.35
			5 pounds yellow, chrome, at 14 cents per pound.	.70
28	11	George Kemp	30 tons (of 2,000 pounds(anthracite stove coal, at $8 per ton.	240.00
			15 tons (of 2,000 pounds) anthracite chestnut coal, at $8 per ton.	120.00

FOR MONTH OF DECEMBER, 1887.

Dec. 5	1 and 2	Pay-rolls, November	1 superintendent	150.00
			2 assistant superintendents, at $100 each.	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			1 foreman	75.00
			1 watchman	75.00
			2 watchmen, at $50 each	100.00
			2 watchmen, at $45 each	90.00
			2 lockmen, at $60 each	120.00
			2 lockmen, 1 month and 28½ days, at $50 each.	97.50
			11 lockmen, 10 months and 6¾ days, at $45 each.	460.12
			1 diver, ½ day, at $7.50 per day	3.75
			1 foreman	75.00
			1 carpenter, 260 hours, at 25 cents per hour.	65.00
			1 tinner, 95¾ hours, at 25 cents per hour	23.94
			1 scrubber, 95 hours, at 15 cents per hour.	14.25
			19 laborers, 2,561 hours, at 17½ cents per hour.	448.15
Nov. 8	3	John Hickler	½ hour's work with steam-hammer, at 75 cents per hour.	37
26	.....	.....do	1 hour's work with lathe-hammer, at 60 cents per hour.	60
			2¼ hours' work with drill, at 60 cents per hour.	1.35
28	.....	.....do	2 hours' work with drill, at 60 cents per hour.	1.20
Dec. 31	4	George H. Smith	Rent of one storage room in Detroit, Mich., from October 1 to December 31, 1887 (both days included), being 3 months, at $100 per year.	25.00
31	.....	Pay-roll, December, office supervising engineer.	2 clerks, at $175 per month	350.00
			1 clerk	100.00
			1 draughtsman	175.00
			1 copyist	50.00
			1 messenger	50.00
			1 scrubber	5.00

mized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF JANUARY, 1888.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
888.				
n. 4	1 and 2	Pay rolls, December, 1887...	1 superintendent	$150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman, $\frac{13}{30}$ month, at $80	29.33
			1 foreman, $\frac{11}{30}$ month, at $75	27.50
			1 watchman, $\frac{12}{30}$ month, at $75	30.00
			2 watchmen, 13$\frac{1}{2}$ days, at $50 month each	22.50
			2 watchmen, 1$\frac{11}{30}$ months, at $45 each	61.50
			2 lockmen, $\frac{22}{30}$ month, at $60 each	44.00
			2 lockmen, $\frac{22}{30}$ month, at $50 each	33.34
			10 lockmen, 3$\frac{22}{30}$ months, at $45 each	165.00
			2 divers, 2 days, at $7.50 per day each	15.00
			1 carpenter, 270 hours, at 25 cents per hour	67.50
			1 tinner, 26$\frac{1}{2}$ hours, at 25 cents per hour	6.65
			1 scrubber, 40 hours, at 15 cents per hour	6.00
1887.				
t. 21	3	T. B. Rayl & Co	1 dozen axes	7.50
			$\frac{1}{2}$ dozen adzes, carpenter's, at $13.50 per dozen.	6.75
			$\frac{1}{2}$ dozen augers, $\frac{11}{16}$-inch	1.30
			25 pounds Babbitt metal, genuine	6.63
			$\frac{1}{4}$ dozen brushes, dust, at $8 per dozen	2.00
			$\frac{1}{2}$ dozen brushes, stove	1.00
			1 only block galvanized iron, $\frac{3}{8}$-inch	.75
			2 only blocks, galvanized iron, $\frac{1}{2}$-inch	1.40
			2 only basins, wash	1.20
			1 only basin, urinal	3.10
			1 dozen cutter wheels, No. 2	3.50
			1 dozen cutter wheels No. 1	3.00
			50 pounds copper, sheet, 1-32 inch thick	11.00
			4 only cans, oil, 1 quart	1.20
			$\frac{1}{2}$ dozen cuspidors, cast iron	4.00
			2 only dippers, 4 quart	1.25
			1 dozen files, flat, 12-inch, smoothing	3.35
			$\frac{1}{2}$ dozen files, bastard, 10-inch	2.65
			1 dozen files, saw, 8-inch	1.15
			2 only funnels, galvanized iron	1.50
			$\frac{1}{4}$ dozen forks, hay, 3-tined	1.50
			2 only feeders, for No. 50 Garland	3.50
			2 only grates, for No. 50 Garland	1.50
			1 only grindstone and fittings, 100-pound	2.50
			1 dozen handles, hammer	.75
			1 dozen handles, sledge	2.10
			1 dozen handles, file	.25
			1 dozen handles, cross-cut saw	2.25
			1 dozen handles, adz	2.60
			2 only hammers, machine	1.75
			1 only hammer, copper	18.00
			$\frac{1}{2}$ dozen hasps, door, 8-inch	.40
			3 only locks, door, Yale	4.50
			$\frac{1}{2}$ dozen locks, pad	2.40
			2 sets mica for No. 50 Garland	4.00
			10 kegs nails, cut, steel, 10-inch	27.50
			2 kegs nails, cut, steel, 6-inch	6.00
			1 keg nails, cut, steel, 4-inch	3.25
			1 keg nails, wrought, 10-inch	3.40
			1 keg nails, wrought, 8-inch	3.65
			12 packages nails, finishing, 2-inch	.75
			12 packages nails, finishing, 1$\frac{1}{2}$-inch	.75
			3 only nuts for guard-gate valve	60.00
			1 only pump, tin	1.25
			500 feet pipe, gas, 1-inch black	26.50
			1 dozen picks, railroad, adz-eye	7.50
			2 dozen packages polish, stove	1.20
			$\frac{1}{4}$ dozen pans, dust, tin, No. 1	.35
			$\frac{1}{2}$ ream paper, emery	3.00
			$\frac{1}{2}$ dozen peavys, lumberman's	14.50
			2 only pots, fire, for No. 50 Garland	6.50
			6 pounds rivets, with burrs, copper-inch $\frac{3}{8}$	1.80
			2 pounds rivets, with burrs, copper-inch $\frac{1}{4}$	.60
			1 only stove, Tremont No. 2	18.50
			1 only stove, Garland No. 30	32.00
			$\frac{1}{2}$ dozen bars solder, extra, $\frac{1}{2}$ by $\frac{1}{2}$	1.30
			1 dozen shovels, steel, railroad	10.76
			3 only saws, cross cut, 5-foot	4.25
			2 only squares, carpenters'	2.56

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF JANUARY, 1888—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.		Total.
1887.					
Oct. 21	3	T. B. Rayl & Co	4 only scuttles, coal, galvanized iron		$2.40
			½ dozen shovels, fire, iron		1.20
			1 only screw-driver, steel		.70
			1 only stamp (U. S.)		.75
			3 only sprinklers, water, tin		2.25
			1 only screen, brass wire		3.05
			do		3.20
			½ dozen scythes, cast steel		1.45
			1 dozen scythe stones		.50
			6 gross screws, wood, 2-inch		2.45
			6 gross screws, wood, ¾-inch		1.02
			2 dozen screws, iron, 1-inch		.20
			2 dozen packages tacks, common, 8-ounce		.85
			2 pounds tacks, copper, ¾-inch		.70
			½ dozen valves, check, 1-inch		3.50
			½ dozen valves, globe, 1-inch		3.85
			1 dozen valves, globe, 2-inch pressure		26.00
			1 only wrench, monkey, 6-inch		.45
			1 only wrench, monkey, 7-inch		.55
			2 only wrenches, monkey, 18-inch		2.00
			1 only wrench, pipe, No. 2, Barbans		3.00
			1 only wrench, pipe, No. 3, Barbans		3.75
			100 washers, bolt, ½-inch		.25
			100 washers, bolt, ⅝-inch		.50
			100 washers, bolt, ¾-inch		.65
			100 washers, bolt, ⅞-inch		.70
			100 washers, bolt, 1-inch		.75
			1 dozen wheelbarrows, railroad		19.50
Dec. 28	4	Johnson & Goss	1,029 feet B. M. lumber, common stock, at $12 per M feet	$12.35	
			Less 10 per cent returned	1.23	
					11.12
3	5	F. Fayram, secretary and treasurer, The Detroit Free Press Company.	Advertising for proposals for stationery.		5.78
	6	C. Corbett, manager Western Union Telegraph Company.	Transmission of telegrams on official business to and from Detroit, Mich., as follows:		
Nov. 2			To Washington, D. C., 23 words		.23
3			From Washington, D. C., 19 words		.20
Dec. 8			To Sault Ste. Marie, Mich., 20 words		.20
8			From Sault Ste. Marie, Mich., 24 words		.24
Nov. 21	7	H. D. Edwards & Co	3 dozen brooms, extra heavy, at $2.60 per dozen.		7.80
			2 dozen brushes (scrub), at $2.50 per dozen.		5.00
			1 only belt leather, 10 feet long		2.00
			1 part cement leather belt		1.00
			45 yards cloth cotton, at 9 cents per yard		4.05
			1 dozen chairs, heavy arm		16.50
			10 yards duck cotton, 10-ounce, at 15 cents per yard.		1.50
			½ dozen dusters (feather) at $5.50 per dozen.		1.37
			1 only ensign, United States, 6 by 12 feet		7.15
			1 only ensign, United States, 7½ by 15 feet		10.4
			1 only ensign, United States, 9 by 18 feet		13.
			10 yards red flannel, at 33 cents per yard		3.
			1 only glass, marine, binocular		11
			200 feet halyards (flag), at 1½ cents per foot		39
			96 pieces leather 20 inches diameter, ½ inch thick; 36 pieces leather 30 inches diameter, ½ inch thick.		
			1 side leather (lace) 12 square feet		
			20 pounds marline, first quality, at 15 cents per pound.		
			2 matches, cases, at $1.50 each		
			2 only mats, door rubber, at $1.75 each		
			50 feet packing composition, at 24 cents per foot.		
			2,211 pounds manilla rope, at 11 cents per pound.		
			1 coil rope, cast-steel wire, 2,000 feet, at 16 cents per foot.		
			10 barrels salt, at 95 cents per barrel		
			4 pounds twine, Matre, at 25 cents per pound.		

mixed statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF JANUARY, 1888—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1887.				
v. 21	7	H. D. Edwards & Co	1 only air-pump, Morse improved	$360.00
			1 only driving helmet and breast-plate	88.00
			1 pair diving shoes	10.00
			1 pair diving weights	12.50
			2 only diving dresses, at $30 each	60.00
			2 pair diving pants (canvas), at $2.25 per pair.	4.50
			100 feet diving hose (with couplings), at 32 cents per foot.	32.00
			3 pairs diving mittens, at $4.50 per pair	13 50
			2 pairs mitten rings, at $4.50 per pair	9.00
			1 dozen wristbands, rubber, at $2.50 per pair.	15.00
			1 quart cement	.50
			1 yard patching	1.50
			1 only crotch strap	.50
			2 pairs breast-plate pads at $1.80 per pair	3.60
			2 dozen breast bolts and screws, at $4.50 per dozen.	9.00
1888.				
n. 26	8	Wells W. Leggett, agent Brush Electric Company.	2 only bells, 15-inch gong, at $27 each	54.00
			3 sets brushes for 10-light dynamo, at $1.80 per set.	3.60
			1 dozen brushes for dash-pot	4.80
			25 only bushings, rubber, at 35 cents each	8.75
			12 only bushings, rubber switch, at 35 cents each.	4.20
			6,000 carbons, copper coated, $\frac{1}{16}$ inch, at $25 per thousand.	150.00
			50 sheets cloth, crocus, at 7 cents each	3.50
			2 yards cloth, gum, at $1.15 per yard	2.30
			1 dozen carbon-holders, dash-pot	40.80
			1 dozen carbon-holders, upper	12,60
			1 dozen carbon-holders, lower	12.60
			450 feet cable-submarine, No. 4, at 45 cents per foot.	202.50
			2 only lamps, electric, Brush patent, at $70 each.	140.00
			6 only magnet spools, at $10.50 each	63.00
			12 only magnet spools (small), at $3.25 each.	39.00
			$\frac{1}{2}$ dozen rods, dash-pot, at $2.40 each	1.20
			12 only springs, steel, spiral, at 18 cents each.	2.16
			1 dozen screws, $\frac{3}{8}$ inch long	.12
			1 dozen screws, $\frac{1}{4}$ inch long	.12
			2 dozen screws, $\frac{3}{4}$ inch long, at 12 cents per dozen	.24
			2 sets segment plates, at $3.75 per set	7.50
			10 feet tubing, rubber, at 10 cents per foot.	1.00
			1 dozen thumb-screws	.84
			12 only wires, insulated, 3 feet 9 inches long, at 15 cents each.	1.80
			25 feet wire	1.50
			1,200 feet wire, electric light, No. 8	36.00

FOR MONTH OF FEBRUARY, 1888.

b. 2	1	Pay-roll January, 1888	1 superintendent	150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 watchman	45.00
n. 19	2	Thos. Williamson, manager Detroit Free Press Printing Company.	For 300 copies of advertisement, instructions, specifications, and proposals for white-oak timber.	12.32

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF MARCH, 1888.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1888.				
Mar. 2	1	Pay-roll, February	1 superintendent	$150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 watchman	45.00
Jan. 13 to Jan. 31	2	John Hickler	29½ hours work with steam-hammer, at 75 cents per hour.	22.00
			1 hour's work with drill	.60
			70½ hours' work with lathe, at 60 cents per hour.	42.30
			28 hours' work with planer, at 60 cents per hour.	16.80
Mar. 14	3	Charles F. Backus, secretary and treasurer of the Richmond & Backus Co.	2 only baskets, waste-paper, at 60 cents each.	1.20
			1,000 only blanks, watchman's records	7.00
			3,000 only blanks, vessel reports, at $2.50 per M.	7.50
			1,000 only blanks, rules and regulations	17.00
			500 only blanks, tug reports, at $4 per M.	2.00
			25 only blocks, scratch, 8 by 12, at 15 cents each.	3.75
			25 only blocks, scratch, 6 by 8½, at 10 cents each.	2.50
			2 only books copy-press, 800 pages, at 1.65 each.	3.30
			6 only books, register of lockages, at $7 each.	42.00
			6 only books, statistical register, at $9 each.	54.00
			12 only books, watchman's records, at $1.15 each.	13.80
			480 only books, vessel reports, at $12.50 per hundred.	60.00
			100 only books, tug reports	21.50
			2 dozen books, time, monthly, at $1.80 per dozen.	3.60
			1 only book, diary, 8 by 9¾	.60
			1 only brush, copy press	.40
			25 yards cloth, cotton, at 6 cents per yard	1.50
			1 only cyclostyle duplicating apparatus	12.00
			1,000 only envelopes, official, 4½ by 9½, at 40 cents per hundred.	4.00
			1,000 only envelopes, official, 3¾ by 8¾, at 35 cents per hundred.	3.50
			250 only envelopes, official, 3⅝ by 6, at 40 cents per hundred.	1.00
			500 only envelopes, plain, 3⅝ by 6, at 21 cents per hundred.	1.05
			50 only envelopes, box, 4 by 9½, at $3 per hundred.	1.50
			5 pounds gum arabicum, at 85 cents per pound.	4.25
			3 quarts ink, Arnold's, at 38 cents per quart.	1.14
			2 quarts ink, copying Faber's, at 50 cents per quart.	1.00
			1 quart ink, Worthington's	.75
			1 pint ink, crimson, Carter's	.30
			3 bottles ink, indelible, for cyclostyle, at 60 cents each.	1.80
			500 sheets paper, blotting, 19 by 24, at 60 cents each.	3.00
			500 half sheets paper, writing, official head, at $8.40 per M.	4.20
			1,000 half sheets paper, writing, official	5.40
			1 ream paper, foolscap	2.80
			1 ream paper, note	1.25
			300 sheets paper, prepared for cyclostyle at $4.15 per hundred.	12.45
			300 sheets paper, unruled, 14 by 17, at 65 cents.	1.95
			3 dozen pencils, Faber's red No. 3, at 35 cents per dozen.	1.05
			2 dozen pencils, Faber's red No. 4, at 35 cents per dozen.	.70
			2 dozen penholders, wood, at 75 cents per dozen.	1.50

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF MARCH, 1888—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1888. Mar. 14	3	Charles F. Backus, secretary and treasurer of the Richmond & Backus Co.	6 boxes pens, Spencerian No. 1, at 80 cents each.	$4.80
			1 only pen for cyclostyle	3.00
			1 only ruler rubber, 18 inch	60
			1 pair shears, office, 13-inch, plated	1.50
Jan. 19	4	A. A. Pomeroy	Advertising for proposals for furnishing white-oak timber.	2.16
19	5	F. Fayram, secretary and treasurer of the Detroit Free Press Company.	Advertising for proposals for furnishing white oak-timber.	3.84
Mar. 6	6	E. S. Wheeler, general superintendent.	Traveling expenses, Detroit to Sault Ste. Marie, Mich.	15.65
Feb. 1 to Feb. 29	7	John Hickler	15½ hours' work with steam, hammer, at 75 cents per hour.	11.62
			379 hours' work with lathe, at 60 cents per hour.	227.40
			29 hours' work with planer, at 60 cents per hour.	17.40
			13¾ hours' work with drill, at 60 cents per hour.	8.25
Mar. 31	8	George H. Smith	Rent of one storage room in Detroit, Mich., from January 1 to March 31, 1888 (both days inclusive), being 3 months, at $100 per year.	25.00

FOR MONTH OF APRIL, 1888.

April 2	1 and 2	Pay-rolls, March	1 superintendent	150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			2 foremen, at $75 each	150.00
			2 watchmen, 1$\frac{13}{31}$ months, at $50 each	98.33
			2 watchmen, 1$\frac{13}{31}$ months, at $45 each	88.50
			2 lockmen, 2 months, at $60 per month	120.03
			2 lockmen, 1$\frac{13}{31}$ months, at $50 per month	93.35
			10 lockmen, 8 months and 28½ days, at $45 per month.	402.70
			1 carpenter, 270 hours, at 25 cents per hour.	67.50
			1 scrubber, 30 hours, at 15 cents per hour	4.50
			1 team, 5 hours, at 50 cents per hour	2.50
			1 blacksmith, 34 hours, at 30 cents per hour.	10.20
			1 machinist, 17½ hours, at 30 cents per hour.	5.25
			1 laborer, 14⅔ hours, at 15 cents per hour	2.20
May 30	3	E. B. Hutchinson, secretary Detroit Electrical Works.	For freight and charges from Sault Ste. Marie to Detroit, Mich., on 1 box electric bells, weighing 200 pounds, at 60 cents per 100 pounds.	1.20
Feb. 23	4	D. W. Brownell, secretary Democrat Publishing Company.	Advertising for proposals for iron tank, cast steel, brass and iron castings, etc.	2.10
Mar. 1 to Mar. 22	5	John Hickler	17 hours' work with lathe, at 60 cents per hour.	10.20
			182¼ hours' work with planer, at 60 cents per hour.	109.35
Apr. 19	6	E. Emery, agent Duluth South Shore and D. R'y.	Freight and charges from Detroit to Sault Ste. Marie, Mich., on one box and one barrel containing electrical apparatus (Bell's battery, etc.), weighing 250 pounds, at 50 cents per 100 pounds.	1.25

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF MAY, 1888.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
1888. May 3	1-2	Pay-rolls, April	1 superintendent	$150.0
			2 assistant superintendents, 2 months, at $100 each.	200.0
			1 clerk	150.0
			1 engineman	90.0
			1 engineman	80.0
			2 foremen, 1 3/30 months, at $75 per month	82.5
			1 watchman, 1 8/30 months, at $75 per month	72.5
			2 watchmen, 1 13/30 months, at $50 each	96.0
			2 watchmen, 2 months, at $45 each	90.0
			2 lockmen, 2 months, at $60 each	120.0
			2 lockmen, 1 month and 24½ days, at $50 each.	90.8
			10 lockmen, 9 3/30 months, at $45 each	409.5
			1 diver, ½ day, at $7.50 per day	3.7
			1 blacksmith, 172½ hours, at 30 cents per hour.	51.6
			1 carpenter, 270 hours, at 25 cents per hour.	67.5
			1 tinner, 11 hours, at 25 cents per hour	2.7
			1 laborer, 20 hours, at 15 cents per hour	3.0
			1 scrubber, 55 hours, at 15 cents per hour	8.2
Apr. 19	3	E. B. Hutchinson, secretary Detroit Electrical Works.	20 cells Leclaaché battery, at 60 cents each.	12.0
			2 wood push buttons, at 25 cents each	.5
			Re-winding 2 skeleton bells, at $2.50 each.	5.0
May 15	4	Burnett & Strachan	1 oil tank	147.0
May 11	5	J. T. Whiting, agent	Freight charges from Detroit to Sault Ste. Marie, Mich., on 4 boxes official books, stationery etc., weighing 1,170 pounds, at 28 cents per 100 pounds.	3.2
Apr. 1 to Apr. 25	6	John Hickler	16½ hours' work with lathe, at 60 cents per hour.	96.75
			4½ hours' work with bolt-cutter, at 60 cents per hour.	2.70
			9½ hours' work with drill, at 60 cents per hour.	5.70
			47½ hours' work with planer, at 60 cents per hour.	28.50
			38 hours' work with steam hammer, at 75 cents per hour.	28.50

FOR MONTH OF JUNE, 1888.

June 4	1-2	Pay-rolls, May	1 superintendent	$150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			2 foremen, at $75 each	150.00
			1 watchman	75.00
			2 watchmen, 2 months, at $45 each	100.00
			2 watchmen, 2 7/15 months, at $45 each	85.50
			2 lockmen, 2 months, at $60 each	120.00
			2 lockmen, 2 months, at $50 each	100.00
			11 lockmen, 10 months, and 27½ days, at $45 each.	491.25
			1 foreman	75.00
			1 carpenter, 270 hours, at 25 cents per hour.	67.50
			1 scrubber, 75 hours, at 15 cents per hour	11.25
			1 machinist, 10 hours, at 25 cents per hour.	2.50
			1 team, 155 hours, at 40 cents per hour	62.00
			1 team, 12½ hours, at 35 cents per hour	4.38
			8 laborers, 1,665 hours, at 17½ cents per hour.	291.37
			1 blacksmith, 6½ hours, at 35 cents per hour.	2.27
May 31	3	Hickler & Green	1,220 pounds cast steel, at 7½ cents per pound.	91.50
			407 pounds brass castings, at 30 cents per pound.	122.10
			816 pounds iron castings, at 3½ cents per pound.	28.56

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

FOR MONTH OF JUNE, 1888—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Total.
June 1	4	Johnson & Goss	4,356 feet, B. M., common pine lumber, at $12 per M. feet, 52.27; less 10 per cent., retained, $5.23.	$47.04
May 31	5	John Hickler	4½ hours' work with steam hammer, at 75 cents per hour.	3.37
			2 hours' work with lathe, at 60 cents per hour.	1.20
June 30	6	George H. Smith	Rent of one storage room in Detroit, Mich., from April 1 to June 30, 1888 (both days inclusive), being 3 months, at $100 per year.	25.00

FOR MONTH OF JULY, 1888.

June 30	1-2	Pay-rolls, June, 1888	1 superintendent	$150.00
			2 assistant superintendents, at $100 each	200.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			2 foremen, at $75 each	150.00
			1 watchman, 29½ days, at $75 per month	73.75
			2 watchmen 1 3/30 at $50 each	96.67
			2 watchmen 3/30 month, at $45 each	43.50
			2 lockmen, 2 months, at $60 each	120.00
			2 lockmen, 2 months, at $50 each	100.00
			13 lockmen, 11 7/30 months, at $45 each	505.50
			1 carpenter, 260 hours, at 25 cents per hour.	65.00
			1 scrubber, 100 hours, at 15 cents per hour.	15.00
			1 team, 2½ hours, at 40 cents per hour	1.00
			12 laborers, 2,361 hours, at 17½ cents per hour.	413.16
				29,898.72

J J 3.

DRY-DOCK AT SAINT MARY'S FALLS CANAL, MICHIGAN.

There is nothing to add to the subject-matter of preceding reports in regard to this work beyond the fact that the construction of the coffer-dam inclosing the site of the proposed lock at Saint Mary's Falls Canal has reached that stage which renders necessary the tearing out of the walls of the old lower lock, and therefore all projects aiming at converting the old State locks into a dry-dock must be considered as disposed of.

The proposition to locate a dry-dock in immediate proximity to the lockage system is as objectionable as ever; but if it should be decided to do so, then the location heretofore referred to, at the eastern end of the area transferred from the Fort Brady military reservation to the canal reservation, is the least objectionable.

Amount (estimated) required for the construction of a dry-dock at the point indicated	$323,872
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,000

Which should be added to the $65,000 (more or less) which it is understood the State of Michigan holds in readiness to transfer to the United States for the purpose of constructing a dry-dock at Saint Mary's Falls Canal.

JJ 4.

IMPROVEMENT OF HAY LAKE CHANNEL, SAINT MARY'S RIVER, MICHIGAN.

The original estimates for this improvement were based upon a project for a channel 300 feet wide and 17 feet deep, leaving the present navigable channel of St. Mary's River at Sugar Island Rapids (about 2¼ miles below the canal), through these into Hay Lake, and then, by way of Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles and obtaining a route which it is practicable to so mark with lights as to be navigable at night—a condition impracticable with the present channel.

The estimated cost of this project was $2,127,292. The project was subsequently modified to increase the depth to 19 feet, and this has been further increased to 20 feet.

The estimated cost of the present project is $2,659,115, subject, however, to change should unexpected difficulties be developed during the progress of the work.

Three appropriations have been made for the work, as follows:

By act of Congress passed August 2, 1882	$200,000
By act of Congress approved July 6, 1884	125,000
By act of Congress approved August 5, 1886	150,000
Total	475,000

The improvement naturally divides into three parts. Beginning with the up-stream part they are—

(1) Channel through Sugar Island Rapids.
(2) Channel through Middle Neebish.
(3) Channel at Sailor's Encampment.

Except a few test-pits at Sugar Island Rapids, the work of excavation has thus far been prosecuted only at Middle Neebish and Sailor's Encampment, and during the past year at Middle Neebish only. No difficulty concerning right of way exists at either locality; but the channel at Sugar Island Rapids must pass, for a portion of the distance, through private property, and it will be necessary to obtain right of way.

LIST OF CONTRACTS IN FORCE DURING FISCAL YEAR.

Contract dated May 22, 1886, with Allen Rains, for hard wood, closed.
Contract dated December 24, 1886, with Hickler & Green, for dredging at Middle Neebish.
Contract dated April 30, 1887, with T. B. Rayl & Co., for hardware, closed.
Contract dated April 30, 1887, with John Spry Lumber Company, for lumber, closed.
Contract dated April 30, 1887, with George W. Edwards & Co., for ship-chandlery, etc., closed.
Contract dated May 13, 1887, with George Kemp, for coal, closed.
Contract dated May 13, 1887, with Alex. Grieve, for meats, closed.
Contract dated May 13, 1887, with C. C. Johns, for vegetables, etc., closed.
Contract dated May 13, 1887, with H. E. Hungerford, for hard wood, closed.
Contract dated June 27, 1887, with John Hickler, for machine work.
Contract dated March 19, 1888, with Hickler & Green, for materials to repair United States tug *Myra*, closed.
Contract dated May 5, 1888, with N. C. Morgan & Co., for meats, vegetables, etc.
Contract dated May 5, 1888, with G. & R. McMillan, for groceries, closed.

H. E. Hungerford delivered one lot of wood under his contract, but failed to deliver the second lot required, causing emergency purchases

in open market of mill-slabs, etc., to run the plant during the remainder of season of 1887.

C. C. Johns went out of business and failed on his contract for vegetables, etc. Bishop Bros. and Alex. Grieve filled the necessary orders during the remainder of season of 1887 at the rates specified in the Johns contract.

PLANT.

The plant on this work consists of one tug, one drill-scow, and one quarter-boat. The tug received extensive repairs during the winter. About two-thirds of her keel timber and planking and all of her inner sheathing is new; her upper works remain unchanged; her boiler was repaired about the legs; her engine received a new throttle, heater, and pump, and was thoroughly repaired in all parts.

The drill-scow has an entire new deck and new planking at both ends under the rake.

The quarter-boat has been calked, painted, and put in good order.

OPERATIONS UNDER CONTRACT OF DECEMBER 24, 1886.

The only contract for excavation in force was that of above date with Hickler & Green for a channel 300 feet wide and 20 feet deep, beginning at section 509. Work has been continued throughout the fiscal year, excepting the period December 1, 1887, to May 28, 1888. The plant consisted of 3 dredges, 1 drill-scow, and the necessary tugs and dump-scows during 1887, and 2 dredges during May and June, 1888.

The soft decomposed rock was first scraped off to a depth varying from 13 to 22 feet. Between sections 509 and 546, where necessary, the rock was then drilled and blasted. For this purpose the contractors built a new drill-scow, carrying two Ingersoll drills, which were operated with steam and hydraulic power. The number of holes drilled and blasted per day ranged from 21 to 68; the average being about 50. The cartridges used were 2 inches in diameter and 3 feet long, and were from 50 to 54 per cent. nitro-glycerine. The contractors manufactured it in their powder-house on Neebish Island till the 23d August, when the acids caught fire and half a ton of powder exploded, demolishing the powder-house, and also the store-house, 50 feet away, but the 1,200 pounds of powder in it did not explode. From sections 546 to 579 only two lines of holes were drilled down the side channel-lines. As hard rock as there is in the Middle Neebish was excavated from this area by Carkin, Stickney & Cram's new dredge No. 10, working for Hickler & Green.

The amount of material excavated down to the 20-foot grade and paid for is 34,301 cubic yards, costing $1.95 per yard, or a total of $66,886.95.

The amount excavated above 20-foot grade is 44,086 cubic yards; amount excavated from prism is 48,219 cubic yards. The scow measurement was 57,683 cubic yards, and exceeds bank measurement by 31 per cent. in the first instance and 19 per cent. in the second instance.

The contractors are working between sections 509 and 579, and the total excavation for that area will be 58,312 cubic yards, which at $1.95 per yard amounts to $113,709.38.

PROGRESS OF WORK AND COST TO JUNE 30, 1888.

The following is a statement of the amount of material excavated, under the different contracts, from Sugar Island Rapids, Middle Nee-

bish, and Sailor's Encampment, including the cost per cubic yard under the different contracts, the total cost, and the cost per cubic yard for the whole:

Contracts, etc.	Total cubic yards excavated above 20-foot grade, B. M.	Total cubic yards excavated from prism, B. M.	Total cost.	Cost per cubic yard, B. M.
February 28, 1883	161,701.1	201,080	$116,424.79	$0.72
September 5, 1884	46,527	59,411	26,985.66	.58
May 18, 1885	58,330	58,583	51,913.70	.89
Experimental work, dredge and drill	34,531	36,113	51,634.49	1.49
December 24, 1886	34,301	48,219	66,886.95	1.95
Sailors' Encampment	.....	6,644	23,193.63	3.49
Test pits, Sugar Island Rapids, scow measure	.....	1,160	274.93	.24
Excavated at Sugar Island Rapids for filling cribs for coffer-dam. No cost to the United States	.....	16,862	.....	.....
Engineering and office and sundry expenses	.....	.....	60,216.68	.....
Total	335,390.1	.....	397,530.23	1.18
	.....	428,072		.93

LEVEL LINE.

In order to determine the fall of the river between the Middle Neebish and Sailor's Encampment, bench-mark No. 2, at head of Neebish Island, will be connected by a line of precise levels with the bench-mark near Johnson's Dock, on Sailor's Encampment Island.

In November the cutter crew were employed at a cost of $187.32 in cutting out a line between the two bench-marks, a distance of about miles. The islands were thickly wooded with maple, cedar, poplar alders, etc.

GENERAL REMARKS.

This work has been under the local charge of Assistant Engineer E. S. Wheeler, with Mr. Joseph Ripley, assistant engineer, immediately in charge. The latter has personally attended to all the field-work, being aided at times in inspection and computations by Inspectors Common and Callard, and Subinspectors Reed, Kallman, Mangelsdorf, and Poe.

The advantages of this improvement have been so fully set forth in preceding reports, notably beginning at page 2362 of the Annual Report of the Chief of Engineers for 1882, page 1836 of the Report for 1883, page 2004 of the Report for 1884, and page 2098 of the Report for 1885, that it is not deemed necessary to repeat them.

It is an important part of the system for the amelioration of the general navigation of the Great Lakes, and if it had been available during the fiscal year just closed it would have been used by vessels carrying more than 5,581,169 tons of freight and 29,494 passengers.

The first estimates for this work were those of the late Lieutenant-Colonel Weitzel, Corps of Engineers, amounting to $2,127,292, submitted with his report dated January 14, 1882, printed as House Ex. Doc. No. 54, Forty-seventh Congress, first session, and at pages 3262 *et seq.* of the Annual Report of the Chief of Engineers for 1882, they were based upon a project which contemplated a channel depth of 17 feet.

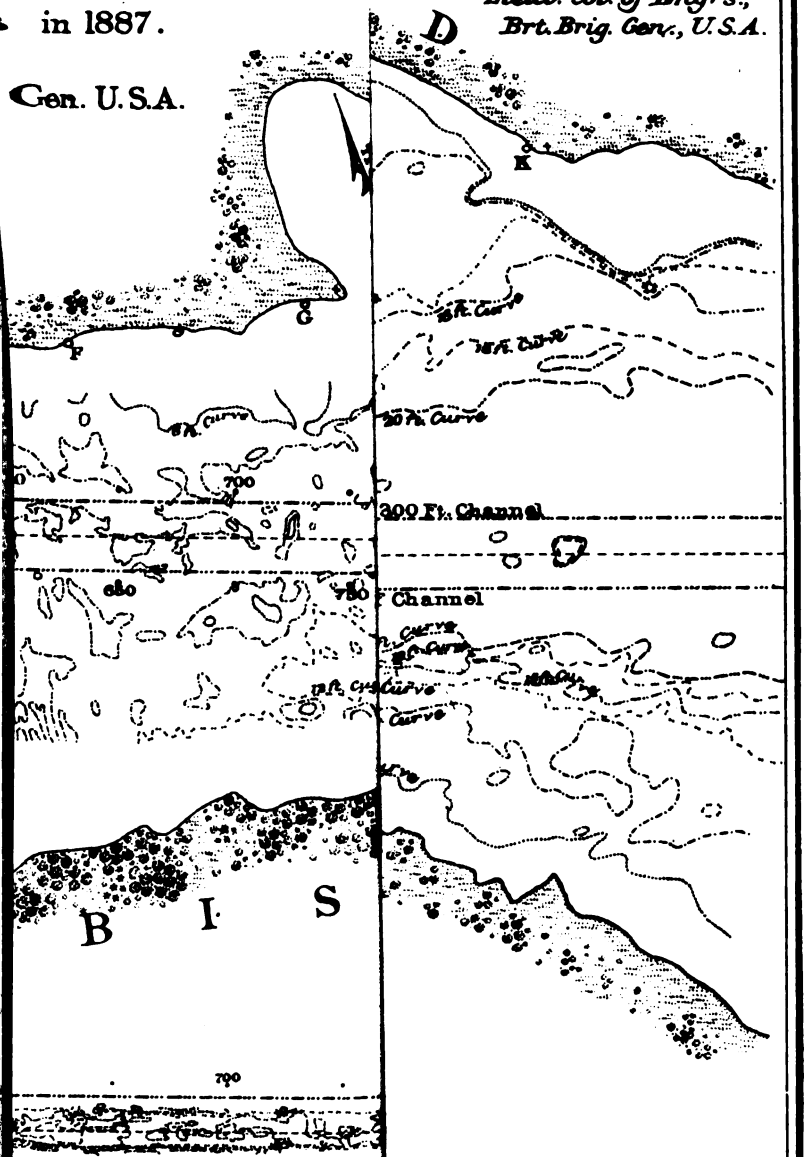
The project having been modified with a view to a depth of 20 feet, a modification of the estimates will probably be required, but the work has

VER, MICH.,
CHANNEL.
vement
s in 1887.

Gen. U.S.A.

gineer Office, Detroit, Mich.
Report for the fiscal year

Lieut. Col. of Engrs.,
Brt. Brig. Gen., U.S.A.



ot yet sufficiently advanced to determine whether the sum ($2,659,115) btained by simply increasing by 25 per cent. the estimate for a 17-foot hannel is greatly in error. I am inclined to think it is not. It will epend in some degree upon the rate at which appropriations are made. With larger appropriations better contracts can be made, and at the ame time the ratio of contingent expenses reduced.

Thus far the appropriations have not been sufficient to warrant underaking operations at more than one locality. But they should now be egun at Sugar Island Rapids, without at the same time reducing them t Middle Neebish. At the present rate (an average of about $100,000 er year) it will take more than twenty-five years to complete the work.

With a view to more rapid progress and greater economy in carrying n this important work, which everybody admits should be made availble as soon as possible, the sum of at least $500,000 should be approriated, one-half to be spent at each of the two localities named above.

At present this channel has no commerce worth mentioning, nor will have until it is made navigable for the through traffic, when its comerce will be practically measured by that through St. Mary's Falls anal, a statement of which is given in connection with the report on perating and care of that work.

Ordinarily this, in common with all other improvements along the ater route between Lake Superior and the lower lakes, is spoken of as Michigan work, whilst the fact is that Michigan's interest is only about 7 per cent., the remainder pertaining to New York, Pennsylvania, Ohio, linois, Wisconsin, Minnesota, Dakota and Montana Territories, and he Dominion of Canada.

stimated cost of 20-foot channel (subject to revision)	$2,659,115
ppropriated to date	475,000
mount yet to be appropriated	2,184,115

The work is located in the collection district of Superior, Michigan; Marquette is he nearest port of entry, but Sault Ste. Marie is a sub-port.

The nearest light-house is the beacon on the pier at the western end of St. Mary's alls Canal.

Money statement.

uly 1, 1887, amount available		$152,540.29
uly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$72,005.08	
uly 1, 1888, outstanding liabilities	6,941.77	
uly 1, 1888, amount covered by existing contracts	73,593.44	
		152,540.29
Amount appropriated by act of August 11, 1888		500,000.00

Amount (estimated) required for completion of existing project	1,684,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for furnishing stationery for improving Hay Lake Channel, Sault Ste. Marie River, Michigan, received and opened December 23, 1887, in accordance with advertisement dated December 3, 1887.

No.	Name and residence of bidder.	Approximate total.	Remarks.
1	The Richmond & Backus Company, Detroit, Mich.	$178.71	Recommended for acceptance.

Abstract of bids for one pump, heater, throttle, and castings for improving Hay Lake Channel, Sault Ste. Marie River, Michigan, received and opened March 5, 1888, *in accordance with advertisement dated February* 23, 1888.

No.	Name and residence of bidder.	Pump, heater, throttle, and castings.	Remarks.
1	Hickler & Green, Sault Ste Marie, Mich.....	$261	Recommended for acceptance.

Abstract of bids for supplies for improving Hay Lake Channel, Sault Ste. Marie River, Michigan, received and opened on April 23, 1888, *in accordance with advertisement dated April* 3, 1888.

No.	Name and residence of bidder.	Approximate total of groceries.	Approximate total of meats.	Approximate total of vegetables.	Remarks.
1	G. & R. McMillan, Detroit, Mich. ...	$228.80	.....	.....	Recommended for acceptance.
2	Jacob Hull & Co., Detroit, Mich	236.90	.....	.....	
3	David Wallace, Detroit, Mich	238.94	.....	.....	
4	Hull Brothers, Detroit, Mich.....	247.81	.....	.....	
5	Peppard & McKinney, Sault Ste. Marie, Mich.....	249.44	.....	.....	
6	Otto Supe & Co., Sault Ste. Marie, Mich	250.31	.....	.....	
1	N. C. Morgan & Co., Sault Ste. Marie, Mich	.....	$293.12	$407.25	Recommended for acceptance.
2	Bishop Bros., Sault Ste. Marie, Mich.	.....	420.00	536.25	

JJ 5.

IMPROVEMENT OF HARBOR AT CHEBOYGAN, MICHIGAN.

Prior to undertaking any improvement at this harbor only 6½ to 7 feet of water could be carried across the bar at the mouth of Cheboygan River.

The original project for the improvement, adopted in 1871, contemplated dredging a channel 200 feet wide and 14 feet deep through the bar, and revetting each side by a sheet-pile pier, at an estimated cost of $395,335.

A history of the progress of the work of improvement to the year 1876 is given at pages 530 and 531, Report of the Chief of Engineers for 1876, and its history from that time to the close of the fiscal year ending June 30, 1887, is given at pages 2247 and 2248, Annual Report of the Chief of Engineers for 1887. The project, as it stood at the close of the last fiscal year, provided for a channel depth of 15 feet for the full width of 200 feet, to be carried as far up the river as the available funds would permit.

Because of the low price for excavation under the contract of June 1887, more was accomplished than was foreseen, and the work was carried up-stream to a formation of hard-pan which was known to exist but which it was not expected could be reached with the funds then available, and was therefore not included in the specifications under which the proposals were made upon which that contract was based. The work done was paid for from balances of former appropriations, leaving untouched the entire amount of the appropriation of August 5, 1886.

A further project for dredging was submitted February 4, 1888, and

approved by the Chief of Engineers under date of February 8. It proposes to continue the 15-foot channel up-stream to the State Road bridge.

Consequently the project for the improvement, after its several modifications, now contemplates a channel 15 feet deep, and generally of 200 feet in width, from the 15-foot curve in the Straits of Mackinac, to the first bridge, and the revetting of both sides of the channel outside the shore-line. Thus far the channel already dredged stands so well that the construction of this revetment has been deferred, and it is highly probable will never be required.

At the beginning of the fiscal year but one contract was in force, namely, with the Green Bay Dredge and Pile Driver Company, dated June 6, 1887, for dredging, at 11½ cents per cubic yard.

A survey of the channel undertaken in the winter of 1886–'87 was interrupted because the ice proved insufficient to permit its completion. Before the dredge could be properly located it was necessary to extend the soundings up-stream, and between August 2 and 11 they were carried as far as McArthur's steam-boat dock. Under the contract referred to above, the actual work of dredging began on the 5th of August, and continued until the 24th of October, when, the specifications having been exhausted, the contract was closed. The result was the removal of 29,979 cubic yards of material, at a cost for dredging of $3,447.58.

Except for the fact that all of the material of the character specified had been removed, the appropriation would, at the contract price, have sufficed to remove a total of 162,000 cubic yards, or more than three times the entire amount remaining to be excavated to carry the 15-foot channel to the State Road Bridge, estimated at 45,000 cubic yards. The remarkably low price for dredging under this contract accounts for the work having been carried further than was anticipated.

The material remaining to be removed is specified as hardpan, bowlders, and clay, with a small quantity of overlying sand and sawdust. By advertisement, dated February 18, 1888, proposals were invited for the required excavation. The bids were opened March 19, 1888, and as a result, a contract, dated April 3, 1888, was entered into with Chauncey E. Mitchell, who agrees to do the work at the price of 14.4 cents per cubic yard, measured in the scows, and to complete it by December 1, 1888. This is a very low price, and if the contractor does not fail, the present appropriation will be more than sufficient to complete the channel. But I fear that he has undertaken the work at so low a figure that he will be unable to complete it. I feel sure that he can not do so without loss. He has not yet begun operations, but expects to do so early in July.

The commerce of Cheboygan is steadily increasing, and the harbor is of greater importance than it was supposed it would be when the improvement was first undertaken. It is gratifying that so good a result should have been obtained at a cost so much below the original estimate.

The harbor is also used as a harbor of refuge, a large number of vessels taking shelter here during the year.

The work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich., and the nearest lighthouse stands on the pier-head marking the outer end of the channel.

Money statement.

July 1, 1887, amount available		$19,291.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,976.08	
July 1, 1888, amount covered by existing contracts	14,315.12	
		19,291.20

Amount appropriated by act of August 11, 1888 ..... $15,000.00

Amount (estimated) required for completion of existing project 70,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for dredging harbor at Cheboygan, Mich., received and opened March 19, 1888, in accordance with advertisement dated February 18, 1888.

No.	Name and residence of bidder.	Price per cubic yard, scow measure.	Remarks.
		Cents.	
1	Chauncey E. Mitchell, Ludington, Mich	14.4	Recommended for acceptance.
2	Charles F. Dunbar, Buffalo, N. Y	43	
3	Carkin, Stickney & Cram, East Saginaw, Mich	44	
4	William Richardson, Buffalo, N. Y	45	
5	Hickler & Green, Sault Sainte Marie, Mich	46	
6	L. P. & J. A. Smith, Cleveland, Ohio	69	

Table, compiled from the custom-house books, showing the number and tonnage of vessels entered and cleared, from the opening of the season to October 27, 1887.

	Steam-vessels.		Schooners and barges.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Entered	466	108,102	319	93,859	785	201,961
Cleared	477	109,497	325	94,463	802	203,960
Total	943	217,599	644	188,322	1,587	405,921

Amount collected, $346.55.

Table showing the tonnage and number of line steamers stopping at Cheboygan during the same period, that do not appear on the custom-house books.

	Tonnage.	Trips (2 stops each trip).	Number of boats.	Tonnage.
City of Alpena	1,221	54	108	131,868
City of Mackinac	808	53	106	85,648
Atlantic	656	32	64	41,984
Flora	562	31	62	34,844
Total	3,247	170	340	294,344

Summary of shipments out and in.

Articles.		Out.	In.
Lumber	feet, B. M.	100,000,000	
Lath	pieces	20,000,000	
Pickets	do	1,000,000	
Shingles	do	8,000,000	
Cedar railroad ties	do	815,000	
Cedar telegraph poles	do	37,000	
Cedar posts	do	130,000	
Fish	tons	1,000	
Flour	barrels	2,000	2,0
General merchandise	tons	6,000	1,0
Brick	pieces	200,000	2,00
Coal	tons		

J J 6.

IMPROVEMENT OF HARBOR AT THUNDER BAY, MICHIGAN.

The project for the improvement of this harbor was adopted in 1876, the object being to obtain an entrance channel from the bay into the river of navigable width and of not less than 13 feet in depth. The project was subsequently modified to such extent as to provide for a depth of 14 feet.

This had been practically accomplished at the date of the Annual Report for 1884. It was then stated that the improvement was of such a character that it would require attention from time to time, and it was recommended that a sufficient appropriation be made to render available the sum of $10,000 for use when it should be wanted. This was not done, however, and the matter has remained in abeyance.

Until recently no complaint of insufficient depth of water in the harbor has reached this office. This was undoubtedly due to the good stage of water in Lake Huron. But the expected deterioration of the channel has certainly been going on; and this, in conjunction with a low stage of water and the use of larger vessels than formerly, has caused a very general demand for not merely the restorations of the 14-foot channel, but its further improvement to 18 feet.

To fully restore the 14-foot channel will require the expenditure of about $10,000, and of this amount the sum of $4,510.91 is now available, leaving $5,489.09 to be appropriated if the present project be continued. If the depth is to be made 16 feet, the sum required will be $30,000, in addition to the $4,510.91 now available.

The commerce directly benefited by this improvement is that to and from Thunder Bay River, at the mouth of which is situated the important and rapidly growing city of Alpena.

The following statistics of the commerce of Thunder Bay River for the season of 1887 were kindly furnished me in writing by Mr. Casper Alpern, deputy collector of customs at Alpena, namely: Total tonnage of vessels entered and cleared during season of 1887, 750,000 tons.

Amount and value of exports for the same season.

		Quantity.	Value.
Lumber	feet, B. M.	220,000,000	$2,640,000
Lath		50,000,000	60,000
Shingles		38,000,000	114,000
Wood pulp	pounds	3,500,000	175,000
Lime	barrels	5,000	3,750
Fish	pounds	1,500,000	70,000
Cedar ties		830,000	160,000
Cedar posts		885,000	32,000
Telegraph poles		25,000	12,250
Total value of exports			3,267,000
Total value of miscellaneous merchandise imported by vessels during the same time			2,000,000
Total			5,267,000

It is apparent from the foregoing that the commerce of this harbor is well worthy of consideration, and I therefore venture to recommend that the depth be made 16 feet, and that for this purpose the additional sum of $30,000 be appropriated, thus making the whole sum $34,510.91. With this amount in hand the work can be done in one year.

This work is located in the collection district of Huron, Mich. The nearest port of entry is Port Huron, Mich., and the nearest light-house is at the work.

Money statement.

July 1, 1887, amount available	$4,525.07
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14.16
July 1, 1888, balance available	4,510.91

Amount (estimated) required for completion of proposed project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	34,510.91

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

J J 7.

IMPROVEMENT OF HARBOR AT AU SABLE, MICHIGAN.

The present project for the improvement of this harbor was adopted in 1866 and modified in 1879, the object being to obtain a channel of not less than 10 feet in depth for a width of 100 feet, from the lake to the State Road Bridge at Au Sable. The attempts to improve this harbor have not been as successful as had been hoped. The reasons for this are fully set forth in the Annual Report of 1885. (See pages 2130 *et seq.*, Annual Report of Chief of Engineers for 1885.)

An inspection of the works pertaining to this improvement, made on the 8th June, 1888, only served to confirm the opinion heretofore expressed, that it is not possible to make any permanent improvement of the harbor at a cost commensurate with the advantages to be gained.

The training-walls inside the river are generally in as good condition as could be expected, and still serve their purpose. The north pier is much out of repair, the upper courses of timber in the superstructure decayed and broken, and a very considerable portion of the stone filling gone from the cribs.

The crib portion of the south pier is in tolerable condition. In 1881 a pile and edging revetment 850 feet long was built in extension of the crib-work of the south pier. The inner 200 feet of this is in fair condition, and answers its purpose. The remainder is either gone or in such condition as to form more of an obstruction than benefit to the harbor.

The shipments from this port are large and important, consisting of lumber, lath, salt, etc., but are principally made from private piers built into the lake, entirely outside of the harbor.

For the reason expressed above, no estimate for this work is submitted for the fiscal year ending June 30, 1889.

This work is located in the collection district of Huron, Mich. The nearest port of entry is Port Huron, and the nearest light-house is at the work.

Money statement.

July 1, 1887, amount available	$4,861.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	15.76
July 1, 1888, balance available	4,845.77

J J 8.

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

In 1866 the mouth of Saginaw River was obstructed by a bar in Saginaw Bay, about 1 mile from shore, and a half mile across it between the 10-foot curves, with a minimum depth of about 9 feet.

Between the mouth of the river and Bay City, a distance of about 5 miles, the depth varied from 15 to 30 feet. Thence to the head of the river, a distance of 16 miles, the channel was obstructed by a number of bars having only 7 feet of water, thus limiting the navigable depth to about 7 feet, although the prevailing depth varied between 12 and 20 feet.

The original project for the improvement of the river was made in 1866, and contemplated dredging a straight channel across the bar at the mouth, 12 feet deep and 195 feet wide. This was completed in 1869, the length being 6,800 feet.

In 1874 a project for improving the river above Bay City was adopted. It included dredging a 10-foot channel across the bars at East Saginaw and Carrollton and the construction of a pile revetment along one side of the new channel at the latter place. To this were added, in 1876, projects for similar improvements at Zilwaukie Bar and New York Works Bar, and in 1879 at Willow Island. Under these projects work slowly progressed until 1881.

In 1882 a Board of Engineers considered the subject of the general improvement of Saginaw River, and recommended that the channel be made 200 feet wide and 14 feet deep from Saginaw Bay to Bay City, and 12 feet deep thence to the head of the river, a total distance of about 23 miles.

The details of the project are given at pages 1863 *et seq.* of the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1883, to which I respectfully refer.

An addition to the project has been made, providing for the repair and extension of the revetment confining the Carrollton Channel and the construction of similar works at the head of Crow Island for the improvement of Zilwaukie Bar.

Congress directed that $5,000 of the appropriation of August 5, 1886, shall be expended in improving the west channel along West Bay City. This is also in addition to the project submitted by the Board of Engineers in 1882.

At the beginning of the fiscal year the condition of the several sections of the work, prosecuted in accordance with the approved projects for the expenditure of the appropriation made by the act of August 5, 1886 (see page 2251, Annual Report of the Chief of Engineers, 1887), was as follows:

(1) Dredging the channel across the bar at the mouth of Saginaw River, under contract with Carkin, Stickney & Cram, had been commenced, but was interrupted on June 29, 1887, by the failure of their dredge.

(2) A contract dated June 21, 1887, had been entered into with Hubbell & Skeldon for dredging the west channel along West Bay City.

(3) At Carrollton the repairs of the beam-wall had been completed except the filling with mill edgings; the reinforcement of the beam-wall was in progress, and the dismantling of the revetment, preparatory to making the proposed repairs had been commenced.

For the purpose of duly prosecuting the works the following contracts were in force, viz:

With Carkin, Stickney & Cram, dated November 10, 1886, for dredging on the bar at mouth of Saginaw River.

With Hickler & Green, dated November 10, 1886, for dredging on the bar at mouth of Saginaw River.

With Hubbell & Skeldon, Dated June 21, 1887, for dredging west channel, along West Bay City.

With Ozro J. Quinn, dated November 10, 1886, for furnishing, driving, and pulling piles at Carrollton Bar.

With John G. Owen, dated December 8, 1886, for furnishing timber, plank, and edgings at Carrollton Bar.

Under their contract, Hickler & Green commenced work on the 15th July, 1887, in the third dredge-cut west of the axis of the channel across the bar at the mouth of Saginaw River, and by August 27 had excavated 10,559 cubic yards of material, amounting, at contract price, to $4,698.75, when their contract was closed.

Carkin, Stickney & Cram resumed operations under their contract on the 29th August, and continued the above-mentioned cut, completing their contract October 17. During the fiscal year they removed 7,918 cubic yards of material, amounting to $3,523.51. The whole excavation under this contract was 9,218 cubic yards, at a cost of $4,102.01.

Dredging in the west channel along West Bay City was commenced on the 21st July by Hubbell & Skeldon, and only stopped on the 26th August by the exhaustion of the funds available.

The result was one cut completed along the west line of the proposed channel below the north end of the so-called "Cincinnati Mill" Dock, and in front of Davidson's Ship-yard. This cut was 1,830 feet long, and 6,780 cubic yards of sand were removed to give a depth of 12 feet for a width of 25 feet. The shoal immediately above the Portsmouth Bridge was almost entirely removed by making four dredge-cuts and excavating 5,740 cubic yards of sand. The total excavation was 12,520 cubic yards, costing, at the contract price, $3,756.

Above Bay City the work of repair, renewal, re-inforcement, and extension of beam-wall and pile revetment at Carrollton, in accordance with the project (page 2251, Annual Report Chief of Engineers, 1887), was continued until the available funds were exhausted. The expenditure on this account during the fiscal year was $10,410.29. The work accomplished was as follows:

Section I, consisting of the closing of a gap 270 feet in the beam-wall, the pile-work and superstructure of which had been completed prior to July 1, 1887, was filled with 93 cords of mill edgings and covered with a layer of coarse sand 1 foot in depth.

Section II. The re-inforcement of the beam-wall was completed by the addition of 130 new piles, and the pulling and redriving of 19 old ones; all were placed in proper alignment and the old binder timbers bolted to them, and the whole capped with 6 by 12 inch timbers for a length of 2,466 feet.

Section III. On a portion of the revetment, about 970 feet in length, the stone and edging filling was removed to a level about 2 feet above low water; all the old timbers, cross-ties, and walling pieces in the superstructure taken up, and 51 of the old ties pulled. The remainder of the front row of old piles in the revetment having been forced out of alignment and careened over in the channel, were cut off at the water's edge. A new structure was built by driving the 51 piles previously drawn and 374 new ones, all about 40 feet in length, on a new line in front of and at several points intersecting the old line. The piles were

then cut off at a height of 5 feet above low water, walling and binder pieces bolted to them, and the whole surmounted by two courses of 12 by 12 inch timbers. The cross-ties were bolted to the tops of the old piles in the rear of the work, which were cut off level at the proper height for that purpose. The filling was carried up to the bottom of the ties by the addition of 232 cords of mill edgings, the stone replaced, and the whole covered with a layer of sand 6 inches deep, hoping to thus reduce the danger from fire.

About 53 linear feet of the lower end of the new structure could not be filled with edgings because of the exhaustion of available funds.

Section IV consisted of the replacement and extension of the revetment on the same plan as the new work in Section III, except that the width of the structure is made 10 feet over all instead of 14. During the fiscal year 803 linear feet of piling and superstructure, with 124 linear feet of outside planking were put in place, and the rear row of piles was further extended a distance of 789 feet down-stream, and capped with one course of 12 by 12 inch timber. In this section 172 old piles were drawn and redriven in the rear row, and 313 new piles, each 40 feet long, were driven in the front row.

PRESENT CONDITION OF THE WORKS.

1. *Channel across the bar at the mouth of the river.*—The proposed width of channel is 200 feet and depth 14 feet. Only one dredge cut, the first one east of and adjoining the axis of the channel, has been carried through its whole length across the bar. The face of the bar nearest the shore is about 3,300 feet outwards from the range beacon, and all other dredge cuts thus far made have been commenced at the shorewards face of the bar. The following table gives the number of these cuts, and approximately the length to which each has been carried, also approximately the length of each remaining to be excavated to reach the 14-foot curve in Saginaw Bay:

	Dredged.	Remaining to be dredged.
West of axis:	*Feet.*	*Feet.*
Cut No. 4	.....	12,800
Cut No. 3	7,599	5,000
Cut No. 2	7,661	4,940
Cut No. 1	8,120	3,870
East of axis:		
Cut No. 1	12,057	.....
Cut No. 2	8,636	2,990
Cut No. 3	3,360	8,445
Cut No. 4	2,457	10,170
Total	49,890	48,225

2. *West channel along West Bay City.*—Opposite Davidson's ship-yard one dredge cut was made 1,820 feet long, the exact condition of which can not be described in the absence of soundings made since last fall. It is believed, however, that on account of the nature of the river bottom (which consists of fine sand), the proximity of the shore of the middle ground, and the carelessness of tug-men attempting to navigate the new channel previous to its entire completion, this single dredge cut has filled up to a considerable extent. The shoal immediately above the Portsmouth Bridge having been entirely removed, it is probable that

nearly the full depth of 12 feet remains good. I have but little confidence, however, in the permanency of any portion of this work.

3. *Above Bay City.*—The beam-wall, forming the westerly boundary of the Carrollton Channel for a length of 3,000 feet, is in good condition, the repairs and re-inforcement having been completed by the addition of piles along the channel-face with sufficient penetration to strengthen the structure and maintain it in its upright position along the navigable channel of 12 feet in depth. The portion of the revetment along the easterly shore of the river at Carrollton has been thoroughly repaired for a length of 970 feet, except that the lower 53 feet requires filling with mill-edgings and stone. The extension of the revetment down-stream (Section IV) is partially completed, as follows: Eight hundred and three linear feet of piling and superstructure, with 124 linear feet of outside planking, are in place; the rear row of piling is extended a further distance of 789 linear feet, and capped with 12-inch by 12-inch timbers. The height of the repaired and extended revetment has been reduced to 7 feet above standard low water, and the width of the structure in extension of the old work from 14 to 10 feet, thus materially reducing the cost of construction and the danger of destruction by fire.

All piles in the front row are about 40 feet long, and have a penetration of not less than 20 feet, thus insuring the necessary strength and stability notwithstanding the reduced cross-section.

Two fires have occurred in the higher part of the revetment during the fiscal year. The first one, on the 11th April, 1888, resulted in burning the superstructure to the water's edge for a length of 150 feet. Fortunately, the water at the time was nearly 3½ feet above our zero, and in repairing this portion to a height of 7 feet it will only be necessary to rebuild about 3½ feet in height. Already claims amounting to over $200 have been filed for services of fire-tugs in extinguishing this fire.

On June 7 another fire occurred, but of much less extent. The amount of the claims of the fire-tugs for services in the latter case is not yet known, nor does it much matter, as there are at present no funds available for paying any of these claims.

The frequent recurrence of these fires gives rise to a suspicion that they are not all accidental, but that some of them may have their origin either in design or carelessness.

FUTURE OPERATIONS.

The funds available for improving Saginaw River being nearly exhausted, further operations, as well as their location and character, must be determined by the provisions of future appropriations.

The most important part of the original project is the dredging on the bar at the mouth of the river, now about half done. Once completed this is not likely to require much further expenditure for some years, because the material with which the bar is composed is hard and stands well. A channel excavated through has, therefore, a considerable degree of permanence. The amount appropriated for this part of the work should be sufficient to push it far toward completion.

Above Bay City the Carrollton Bar has always been considered of first importance. The means adapted for providing and maintaining the proposed channel are the construction of a pile revetment and beam-wall including the channel between them. Thus far good results have been obtained, but the structures should be extended about 1,200 feet

further, in order to connect with the deep and narow reach of the river that distance below. Judging from the beneficial effect of the work so far as it has progressed, it is reasonable to expect that its completion will secure a permanent improvement.

The construction of a pile-pier or wing-dam at the head of Zilwaukie Bar should also be pushed as rapidly as practicable.

In case funds are designated for the purpose, the improvement of the west channel along West Bay City may be continued by dredging two additional cuts opposite Davidson's ship-yard and removing one or more of the smaller shoals above the Portsmouth Bridge.

This work forms no part of the original project, and its cost should not be reckoned in connection therewith.

The constructions recommended will tend to reduce the amount required for the annual dredging contemplated in the original project at points where this seems to be necessary, but it is not expected that they will entirely obviate such necessity. Annual dredging of greater or less extent will always be required to maintain the channel.

Notwithstanding the temporary character of the benefits derived from this annual dredging, it should be continued, as giving relief to a commerce of nearly 2,000,000 tons, having a value of $20,000,000.

For convenience in referring to it, I repeat the estimate of the last three years, as follows:

Repairs to revetment at Carrollton	$9,000
Extension of revetment at Carrollton	10,000
Dredging at Carrollton	18,000
Revetment at Crow Island	3,000
Dredging at Crow Island	10,800
Continuing dredging opposite and below Bay City	100,000
Dredging at other places for immediate relief	15,000
Total	165,800
From which should be deducted the amount appropriated by the act of August 5, 1886, less the $5,000 applied to West Channel along West Bay City	28,750
Remainder to be appropriated on original project	137,050
To this should be added any sum hereafter to be applied to West Channel along West Bay City, estimated at	20,000
Total	157,050

This amount should be made applicable as follows:

Above Bay City	33,925
Opposite and below Bay City	88,125
For general use on the whole river	15,000
Total	137,050

And this should be increased by whatever amount is intended for use in improving West Channel along West Bay City.

The Saginaw River improvement is located in the collection district of Huron, Mich. The nearest light-house is at the mouth of the river. The nearest port of entry is at Port Huron, Mich.

Money statement.

July 1, 1887, amount available	$26,352.12
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	25,277.99
July 1, 1888, balance available	1,074.13
Amount appropriated by act of August 11, 1888	65,000.00
Amount available for fiscal year ending June 30, 1889	66,074.13

Amount (estimated) required for completion of existing project.....$272,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 137,050.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Table showing the principal products manufactured and shipped from the Saginaw River during the season of 1887; compiled from the Seventh Annual Review of the Saginaw Board of Trade.

Products.	Saginaws (upper river).		Bay City, etc. (lower river).		Total.	
	No. of mills.	Quantity.	No. of mills.	Quantity.	No. of mills.	Quantity.
Pine lumber.....feet, B. M..	33	366,918,238	32	399,457,458	65	766,375,696
Hard-wood lumber.....do....	15	9,332,569	7	3,953,000	22	13,285,569
Shingles.....pieces..	17	125,183,000	8	71,800,000	25	196,983,000
Lath.....do....	22	36,217,000	21	53,656,550	43	89,873,550
Staves.....do....	27	22,484,058	17	16,237,950	44	38,722,008
Headings.....sets..	26	995,743	17	638,000	43	1,633,743
Salt.....barrels..	51	1,115,169	32	891,462	83	2,006,631

Shipments by water.

Products.	Saginaws (upper river).		Bay City, etc. (lower river).		Total.
	Ports of destination.	Quantity.	Ports of destination.	Quantity.	
Lumber.....feet, B. M..	12	138,344,000	26	347,762,000	486,106,000
Shingles..... pieces..	4	26,113,000	7	59,605,000	85,718,000
Lath.....do....	5	8,328,000	8	17,968,000	26,296,000

Logs received from tributaries of Saginaw River.....	feet, B. M..	362,701,110
Logs received from tributaries of Saginaw Bay.....	do....	96,793,018
Logs received from Upper Michigan.....	do....	35,000,000
Logs received by rail.....	do....	197,351,602
Total logs received in Saginaw River.....	feet, B. M..	691,845,730

J J 9.

IMPROVEMENT OF HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

The present project for this harbor was adopted in 1873. It consists of a breakwater constructed of timber cribs filled with stone, inclosing an area which is to be deepened by dredging where necessary. Its object is to afford a harbor of refuge to vessels in the navigation of the northern and northwestern lakes when caught in heavy weather near the dangerous Point aux Barques, the southerly headland of the mouth of Saginaw Bay.

Prior to 1876 vessels so caught were compelled to run a distance of 60 miles and find a refuge in St. Clair River. After the subsidence of the gale those upward bound had to work their way back again. Few improvements have resulted in greater benefit to the lake commerce, as is fully shown by the infrequency of disasters in the vicinity since it became available.

At the beginning of the fiscal year contracts were in force with

Brooks, Joslyn & Co. for timber and with McNellis & Johnson for stone for filling cribs. The former contract was completed and closed September 12 and the latter October 12, 1887.

The repairs to the main pier and the construction of the new sea-wall were completed as projected. The superstructure on the north end of the south pier was completed for a length of 200 feet. All repairs immediately needed on the west pier were made, and operations closed October 1, 1887.

The work was done by hired labor, using the steam-launch *Sand Beach* to tow the lighters and move the men. The steam-launch *Ethel* was held in reserve.

The fall and winter storms caused some additional damage to the unprotected cribs of the south pier, but did not affect the timber-work of the other piers.

Examinations made this spring by the diver showed the foundations of the main and south piers in good condition. Some holes were found under the west pier, caused by the washing out of the material.

There were no storms of exceptional severity during the winter, and therefore the stability of the new sea-wall has not been subjected to a sufficient test to determine whether it will stand better than the one which was destroyed in the great storm of December 4 and 5, 1885, which so seriously injured the works at this harbor.

Owing to the limited amount of funds available the project for the season of 1888 was confined to a comparatively small amount of dredging and the building of a low superstructure over the unprotected cribs of the south pier.

After due advertisement a contract dated May 16, 1888, was made with Hickler & Green for a dredge, tug, and two dump scows, at the rate of $9.23 per hour of actual work, and another, dated May 16, 1888, with Henry Howard & Co., at the rate of $20 per thousand feet, B. M., for the timber and plank required in the work projected above.

The dredge commenced work June 4, 1888, on the shoal at the north entrance to the harbor and has made excellent progress. It is proposed to entirely remove this shoal to a depth of 20 feet, thus rendering this entrance available at all times. In addition it is expected that the dredge will pick and replace a considerable portion of the stone heretofore washed out of the cribs, as well as dredge some of the shoalest places inside the harbor.

The timber-work projected for the south pier has not yet been commenced. A portion of the timber has been delivered and the work of construction will begin on the 1st of July and be pushed to completion. The operations described will exhaust the available funds.

The original project for this harbor is practically completed, except the superstructure to the south pier and the dredging. The latter is indefinite in amount and depending upon the area dredged. It can be considered completed with the close of this season's work, but may be advantageously continued. The constructions were begun in 1882 and have continued annually since that time. The oldest portions show decay and steps must be taken to replace the timber superstructure in the order of its age by something more durable. No other material than concrete seems to be available, and therefore an estimate is submitted for a sufficient sum with which to make a beginning.

Current repairs will always be required and the custody and control of the harbor must continue, estimates are submitted for these. Dredging should be continued as opportunity offers, and an estimate for this is also included.

The following is a summary of the estimates, viz:

For beginning the construction of a permanent superstructure	$100,000
For current repairs	10,000
For custody and control of the harbor for one year	3,000
For dredging in and about the harbor	15,000
Total	128,000

As the foregoing are estimates for only one year the entire amount should be appropriated in one sum.

As is well known this harbor has little local importance, but is of incalculable benefit to the general commerce of the lakes. The extent to which it is utilized is shown by the tables appended.

One thousand four hundred and ninety vessels, with an aggregate of 471,724 tons register, sought refuge in the harbor during the fiscal year.

The work is located in the collection district of Port Huron. One light-house and three beacons mark the entrances to the harbor.

Money statement.

July 1, 1887, amount available		$35,575.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$19,766.35	
July 1, 1888, outstanding liabilities	4,397.21	
July 1, 1888, amount covered by existing contracts	11,411.94	
		35,575.60
Amount appropriated by act of August 11, 1888		70,000.00
Amount (estimated) required for completion of existing project		58,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		58,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for furnishing stationery, for improving harbor of refuge, Lake Huron, Michigan, received and opened December 2, 1887, in accordance with advertisement dated December 3, 1887.

No.	Name of bidder.	Residence.	Approximate total.	Remarks.
1	The Richmond & Backus Co.	Detroit, Mich.	$51.99	Recommended for acceptance.

Abstract of bids for furnishing one dredge and supplies on account of improving harbor of refuge, Lake Huron, Michigan, received and opened May 7, 1888, in accordance with advertisement dated April 7, 1888.

No.	Name and address of bidder.	Item.	Amount.	Remarks.
1	Hickler & Green, Sault Ste. Marie, Mich.	One dredge, etc	*$9.23	Recommended for acceptance.
2	Charles F. Dunbar, Buffalo, N. Y	do	*12.00	
3	Carkin, Stickney & Cram, East Saginaw, Mich.	do	*12.00	
1	Henry Howard & Co., Port Huron, Mich.	Timber and plank	†2,821.84	Recommended for acceptance.
2	Carkin, Stickney & Cram, East Saginaw, Mich.	do	†2,835.12	
1	George W. Jenks, Sand Beach, Mich.	Lump coal	†375.00	Recommended for acceptance.
1	H. D. Edwards & Co., Detroit, Mich.	Ship chandlery	†222.66	Do.
1	T. B. Rayl & Co., Detroit, Mich.	Hardware	†194.99	Do.
2	Hodgson & Howard, Detroit, Mich.	do	†196.66	
3	J. Jenks & Co., Sand Beach, Mich.	do	†205.48	
1	Frontier Iron and Brass Works, Detroit, Mich.	Hoisting-screws and shackles.	‡264.00	Recommended for acceptance.
2	Wm. A. Wain, Detroit, Mich	do	‡276.00	

* Price per hour. † Approximate total. ‡ Total.

No. 1.—*Record of vessels taking shelter in the harbor of refuge, Lake Huron, Michigan from June* 30, 1887, *to June* 30, 1888.

Direction of the wind at time of entering.	1887.						1888.			Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Apr.	May.	June.	
North:										
Steam	17	47	18	8	17	.....	3	4	8	123
Sail	16	18	3	1	5	.....	1	7	9	60
Tow	5	8	16	14	1	.....	1	.....	10	55
										237
Northwest:										
Steam	16	3	21	77	26	.....	.....	3	2	148
Sail	5	1	10	16	15	.....	.....	1	4	52
Tow	15	.....	22	57	17	.....	.....	.....	.....	111
										311
West:										
Steam	.....	.....	5	52	24	.....	.....	9	5	95
Sail	3	.....	15	22	5	.....	.....	3	9	57
Tow	.....	.....	4	57	11	.....	.....	14	13	99
										251
Southwest:										
Steam	9	6	15	21	30	8	2	3	4	98
Sail	9	8	16	12	12	1	.....	2	9	70
Tow	.....	4	12	3	29	.....	.....	3	1	52
										220
South:										
Steam	.....	.....	.....	3	30	1	.....	3	2	39
Sail	.....	.....	3	2	3	.....	.....	.....	2	10
Tow	.....	.....	.....	1	38	3	.....	5	.....	47
										96
Southeast:										
Steam	2	12	22	18	15	2	1	18	4	94
Sail	3	2	9	15	5	.....	.....	9	9	52
Tow	.....	4	4	3	6	1	4	1	2	25
										181
East:										
Steam	2	3	17	1	3	.....	.....	6	.....	32
Sail	3	6	6	1	.....	.....	.....	1	.....	17
Tow	.....	.....	1	.....	2	.....	.....	2	.....	5
										54
Northeast:										
Steam	10	25	7	6	12	.....	6	10	8	84
Sail	9	4	4	4	5	.....	.....	8	1	35
Tow	.....	10	1	6	4	.....	6	1	3	31
										150
Monthly total:										
Steam	56	96	105	186	157	11	12	56	33	692
Sail	48	39	66	73	50	1	1	32	43	373
Tow	20	26	60	141	108	4	11	26	29	425
Totals	124	161	231	400	315	16	24	114	105	1,490

No. 2.—*Classified table of tonnage, by months, entering the harbor of refuge, Sand Beach, Lake Huron, for shelter, from June* 30, 1887, *to June* 30, 1888.

Months.	Steamer.		Sail.		Tow.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1887.								
July	66	12,014.70	48	3,770.12	20	5,776.67	124	21,591.49
August	96	26,107.34	39	1,812.49	26	10,300.97	161	38,220.80
September	105	36,525.82	66	5,699.48	60	23,470.56	231	65,695.86
October	186	90,654.22	73	8,320.79	141	56,606.77	400	155,581.78
November	157	78,028.47	50	8,358.53	108	44,053.76	315	130,441.06
December	11	3,403.35	1	11.96	4	1,217.04	16	4,632.35
1888.								
April	12	4,133.03	1	53.64	11	3,308.18	24	7,494.85
May	56	15,069.51	32	1,673.89	26	8,457.21	114	25,200.61
June	33	11,138.81	43	2,494.98	29	9,231.54	105	22,865.33
Total	712	277,105.25	353	32,196.18	425	162,422.70	1,490	471,724.13

No. 3.—*Tonnage of vessels taking shelter in the harbor of refuge, Sand Beach, Lake Huron.*

Calendar year.	Tonnage.			Total tonnage.	Total number of vessels.	Average tonnage.
	Steam.	Sail.	Towed.			
1877	63,966	27,699	50,954	142,619	493	289
1878	104,025	39,699	99,282	243,006	781	311
1879	133,080	45,750	100,096	278,926	921	303
1880	158,720	55,630	147,260	361,610	1,317	275
1881	144,645	55,960	127,855	328,460	1,176	279
1882	146,132	26,504	114,067	286,703	1,022	280
1883	177,122	32,713	114,091	323,926	1,139	284
1884	156,518	34,724	122,980	314,222	1,142	275
1885	196,364	29,426	151,607	377,397	1,156	325
1886	196,335	33,790	140,862	370,987	1,304	284
1887	271,327	33,680	153,087	458,106	1,447	317
Totals	1,748,234	415,584	1,322,141	3,485,959	11,900	293

J J 10.

STEAM-LAUNCH OR TUG FOR HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

The steam-launch continues to perform satisfactory service. It would be improved, however, by the insertion amidships of a section 10 feet in length. This could be done with a portion of the $4,098.86 of the original appropriation, understood to be still available, and therefore no additional appropriation is asked for.

Money statement.

July 1, 1887, amount available	$4,098.86
July 1, 1888, balance available	4,098.86

J J 11.

IMPROVEMENT OF ICE-HARBOR OF REFUGE AT BELLE RIVER, MICHIGAN.

The project for this improvement was adopted in 1880, the obj being to obtain a channel 50 feet wide, 13 feet deep to the first brid 12 feet thence to the second bridge, and affording a safe harbor agai running ice.

The work was completed in 1885 according to the project and gi satisfaction.

Nothing further is required at this time, and therefore no estimate submitted.

Belle River is in the collection district of Huron, Michigan. The nea est light-house is at St. Clair Flats Canal.

Money statement.

July 1, 1887, amount available	$47
July 1, 1888, balance available	47

J J 12.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

In 1870 the channel over the bar at the entrance to this river afforded a depth of only 3½ feet, whilst the depth in the river some distance above the bar was 10 feet.

The present project for improvement was adopted in 1870, and modified in 1880. It aims to obtain an entrance channel of 8 feet.

In a report submitted January 23, 1885, a further modification of the project was proposed. This involved straightening the channel of the river at Shoemaker's Bend and minor improvements elsewhere. The full report is printed at page 2190 *et seq.* of the Annual Report of the Chief of Engineers for 1885, to which I respectfully refer for details.

To straighten the channel at Shoemaker's Bend involves the necessity of dredging across a point of land, and title to the requisite right of way must be obtained.

It is understood that the city of Mount Clemens, with this in view, has purchased the whole of the land included in the bend, and has made a deed of right of way to the United States, but the papers in the case did not pass through this office, nor has any notification yet been received that the Attorney-General has approved the title, consequently nothing has been done towards the permanent improvement of the river under the act of August 5, 1888, appropriating $6,000 for the work.

Meanwhile so urgent a demand arose for temporary relief that it was deemed necessary to make a personal examination to ascertain the actual condition of the channel. This was done on the 24th April, and resulted in a recommendation that a sum not to exceed $2,500 be expended in dredging a channel of 7½ feet in depth and about 50 feet in width, consisting of two cuts across all shoals having less than 7½ feet of water upon them, the dredged material to be cast upon the sides of the cuts. Owing to the unusually low stage of water, this depth is quite equal to a depth of 8 feet at ordinary stage. Of course this to be understood as a mere expedient to gain temporary relief, and the expenditure on account of it is not fairly chargeable to the general project.

This recommendation having been approved by the Chief of Engineers, proposals for hiring a dredge and tug by the hour were invited by advertisement dated May 10, and opened May 25, 1888. The contract was awarded to Messrs. Hubbell & Skeldon, who made the lowest tender, namely, $6.45 for the entire outfit, for the actual time the dredge-dipper was at work.

Articles of agreement dated June 4 were duly entered into and work under this contract was begun on the 21st of June, with a prospect of its completion during the month of July, 1888.

The estimated cost of improving Clinton River according to the project of 1885 is $32,926. Of this sum $6,000 was appropriated by act of August 5, 1886, but the expenditure of $2,500 of this for the temporary relief referred to reduces to $3,500, the amount still applicable to the general project, and leaves the sum of $29,426 yet to be appropriated. The work proposed is of such character that, once begun, it should be carried to completion in the shortest possible time. Any other course is liable to result in great wastefulness. I therefore respectfully recommend that the entire balance be appropriated in one sum.

The commercial statistics hereto appended, furnished by the courtesy of Mr. George M. Crocker, are not as complete as it was desired they should be, but as nearly so as can be supplied at this time.

Money statement.

July 1, 1887, amount available		$6,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$81.88	
July 1, 1888, outstanding liabilities	610.50	
July 1, 1888, amount covered by existing contracts	1,807.62	
		2,500.00
July 1, 1888, balance available		3,500.00
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		13,500.00
Amount (estimated) required for completion of existing project		19,426.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		22,926.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for furnishing one dredge and one tug for improving Clinton River, Michigan, received and opened on May 25, 1888, in accordance with advertisement dated May 10, 1888.

No. of bids.	Names and residences of bidders.	Price per hour.	Remarks.
1	Hubbell & Skeldon, Detroit, Mich	$6.45	Recommended for acceptance.
2	George A. Dupius, Detroit, Mich	8.75	
3	John P. Clark, Detroit, Mich	11.00	

COMMERCIAL STATISTICS.

Statement of shipments to and from Mount Clemens, on Clinton River, Michigan, during the season of 1887.

Articles.	Quantity.	Articles.	Quantity.
Lumber ... feet, B. M.	7,000,000	Stave bolts ... cords	7,000
Logs ... do	4,000,000	Headings ... sets	800,000
Shingles ... pieces	4,500,000	Coal ... tons	5,200
Lath ... do	1,500,000	Salt ... barrels	1,000
Cedar posts ... do	15,000	Cement ... do	200
Staves ... do	13,500,000	Building stone ... cords	250

List of steam and other vessels owned, built, or doing business at Mount Clemens, on the Clinton River, Michigan, during the fiscal year ending June 30, 1888.

Name.	Class.	Tons.	When built.	Value.
Ida	Steam-barge	120	Before 1881	$4,000
Missouria	do	400	do	
City of Mount Clemens	do	100	In 1881	15,000
Sokie Shephard	do	128	In 1885	10,000
Atlantic	do	107	In 1887	9,000
J. S. Ruby	do	103	Since 1881	10,000
Weston	do	500	do	25,000
Aloha	do	500	do	25,000
F. R. Buell	do	1,000	do	70,000
Nellie	Steamer, passenger	103	In 1882	15,000
Roberta	Steam-yacht, passenger	21	In 1887	15,000
Banner	Tow-barge	350	Before 1881	
Golden Rule	do	400	do	
H. Moore	Scow	80	do	1,500
North Branc	do	80	do	

J J 13.

IMPROVEMENT OF ST. CLAIR FLATS CANAL, MICHIGAN.

This canal was projected in 1866, with a view to obtaining a straight channel, 13 feet deep and 300 feet wide, across St. Clair Flats, the channel being bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet.

These dikes consist of timber resting upon piles driven into the original bottom of the shoals, the crib-pockets being filled with material dredged from the channel.

To maintain a channel-bank a single row of sheet-piling was driven along the channel-face of the cribs previous to dredging.

The lake sides of the dikes were protected from wave-action by shorter sheet-piling.

In 1873 the channel was deepened to 16 feet by dredging for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all, being thus limited by the fact that the sheet-piling, intended for a depth of 13 feet, have not sufficient penetration to admit of dredging to 16 feet for the full width of 300 feet.

The single row of sheet-piling is also insufficient to prevent the leakage of the dike material through it into the channel, and it is necessary to re-inforce it with a double row, giving them, however, sufficient penetration to admit of subsequent dredging to a depth of 20 feet.

The entire timber structure is much decayed, and should be renewed as soon as possible. Its condition has been duly reported in the Annual Reports for the last four or five years, and there is now nothing to add except that the condition becomes worse with each succeeding year. It has now been in place for an average of twenty years.

By the river and harbor act of August 5, 1886, the sum of $18,750 was appropriated for continuing the improvement.

Under the date of November 15, 1887, a general project was submitted for improving the canal, and a special project for the application of this appropriation.

The general project contemplates driving a double row of sheet-piling to a depth of 26 feet along the channel-face of each dike, dredging the area between them to a depth of 20 feet, continuing the channel above and below the canal to the same depth in river and lake, and rebuilding the wooden superstructure.

The special project aims at completing as much of the sheet-piling as the available funds will permit.

These projects were based upon data contained in the Annual Report of 1885, and have been duly approved. Owing to the rapid increase in the price of materials and labor, the estimate therein given was last year correspondingly modified and increased to $200,000, with the remark that this would probably not hold good for more than two years, when it may be necessary to again increase the estimate. It is exclusive of the cost of dredging the canal to the proposed depth, and this item must therefore be the subject of a future estimate, to be made after the completion of the works immediately in hand.

At the date of the Annual Report of 1887 a contract dated January 7, 1887, with Augustus J. Dupuis, was in force and in progress of execution. It covered the construction of as much of the sheet-piling as the funds appropriated by the act of August 5, 1886, would suffice to pay for. Mr. Dupuis completed his contract considerably within the time specified (December 1, 1887), and in a perfectly satisfactory man-

ner. The bill of materials given upon the drawings showing the proposed work, and upon which the bids and the contract thereunder are based, was prepared for a length of 1,000 feet. Upon actually placing them in the work it was found that, owing to the varying distances apart at which the piling of the old work had been driven, the stated number of new piles, and, in consequence, the iron bolts, spikes, etc. would not complete as many linear feet of new work as had been contemplated, that is to say, would only complete 2,449 linear feet instead of 2,500. However, the contractor had furnished all the material, and had done all the work required for 2,500 feet as specified, and he was therefore paid for that length, although the actual length of new work was only 2,449 feet, or 51 feet less. The actual cost of this and the new walling piece (not included in the contract) was $18,060.24.

The portion of sheet-piling done comprises only one-sixth of what is required. It must all be completed before any work is begun either upon the superstructure or toward deepening the channel, and it should be done as rapidly as possible.

The great importance of this improvement is so well known, its use is so advantageous to a commerce hailing from every lake port, and amounting to nearly 20,000,000 tons per annum, that no additional representation seems to be necessary to secure favorable consideration.

The necessity for the work is immediate and urgent. I therefore recommend that the sum of $100,000 be made available for the fiscal year ending June 30, 1889.

Saint Clair Flats Canal is in the collection district of Detroit, Mich., which is the nearest port of entry. Two light-houses stand upon its banks.

Money statement.

July 1, 1887, amount available	$18,553.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	18,414.24
July 1, 1888, balance available	139.70
Amount appropriated by act of August 11, 1888	75,000.00
Amount available for fiscal year ending June 30, 1889	75,139.70
Amount (estimated) required for completion of existing project	181,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

J J 14.

OPERATING AND CARE OF SAINT CLAIR FLATS CANAL, MICHIGAN.

The canal is in immediate charge of a custodian, who also acts as inspector whenever any work is in progress.

During the past year operations were limited to the necessary supervision of the canal, and the expenditures to the custodian's salary, $1,500, and to the repairs of the boat belonging to the work, amounting to $10, or an aggregate of $1,510.

The estimated cost of operating and care of the canal for the fiscal year ending June 30, 1889, is as follows:

Salary of custodian	$1,500
Current repairs and contingencies which can neither be foreseen nor estimated for in detail, to include a fair proportion of the office of the superintending engineer at Detroit	3,500
Total	5,000

ll of which is provided for by indefinite appropriation (section 4 of river and harbor act of July 5, 1884).

Money statement.

ınt required for fiscal year ending June 30, 1889	$5,000.00
ıce remaining "in hand" from allotment of preceding year, exclusive outstanding liabilities	391.93
tional allotment required for fiscal year ending June 30, 1889	*4,608.07

zed statement of expenditures incurred on account of appropriation for operating and e of canals and other works of navigation as applied to operating and care of Saint ;ir Flats Canal, Michigan, for the fiscal year ending June 30, 1888.

ı of—	Date.	No. of voucher.	Name.	Service.	Amount.
ıt....	1887. July 31	1	W. H. Mott.	For services as custodian at Saint Clair Flats Canal, Michigan, from July 1 to July 31, 1887 (both days inclusive), being one month.	$125
	Aug. 31	2	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from August 1 to August 31, 1887 (both days inclusive), being one month.	125
nber.	Sept. 30	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from September 1 to September 30, 1887 (both days inclusive), being one month.	125
ır....	Oct. 31	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from October 1 to October 31, 1887 (both days inclusive), being one month.	125
ıber.	Nov. 30	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from November 1 to November 30, 1887 (both days inclusive), being one month.	125
ıber..	Dec. 31	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from December 1 to December 31, 1887 (both days inclusive), being one month.	125
ry...	1888. Jan. 31	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from January 1 to January 31, 1888 (both days inclusive), being one month.	125
ary..	Feb. 29	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from February 1 to February 29, 1888 (both days inclusive), being one month.	125
ı.....	Mar. 31	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from March 1 to March 31, 1888 (both days inclusive), being one month.	125
.....	April 30	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from April 1 to April 30, 1888 (both days inclusive), being one month.	125
	April 14	2	John East..	For services as carpenter between April 9 and 14 (both days inclusive), 1888, being forty hours, at 25 cents per hour.	10
	May 31	3	W. H. Mott.	For services as custodian at Saint Clair Flats Canal, Michigan, from May 1 to May 31, 1888 (both days inclusive), being one month.	125
.....	June 30	1	....do	For services as custodian at Saint Clair Flats Canal, Michigan, from June 1 to June 30, 1888 (both days inclusive), being one month.	125
					1,510

J J 15.

IMPROVEMENT OF GROSSE POINT CHANNEL, MICHIGAN.

Within the last two or three years much trouble has resulted from insufficiency of water in the channel off Grosse Point, Mich., at the foot of Lake Saint Clair (head of Detroit River).

This is principally due to the more general use of vessels of heavy draught, and the difficulty is sure to increase with each year until the channel is brought into accord with the projected available depth for the water route between the upper and lower lakes, and no time should be lost in beginning such works as are necessary.

The improvement is one link in the chain projected for the amelioration of the general navigation of the lakes. The work consists in the simple removal, by dredging, of the requisite amount of material under quite favorable conditions.

The commerce using this channel is essentially the same that passes Saint Clair Flats Canal and Detroit River, amounting to something like 20,000,000 tons per year. It would be advisable to make the improved channel 800 feet wide and 19½ feet deep. Such an improvement would involve the removal of about 2,515,000 cubic yards of material, at an estimated cost of $553,300, a very reasonable sum in view of the great advantage to be gained.

At present it would not be advisable to undertake to remove the additional half a foot, because it is not necessary for the immediate relief of commerce, and the cost would be excessive, owing to the long distance over which mere scraping would have to be carried to get this slightly additional depth.

Believing this improvement to be necessary and urgent, I venture to bring it to the notice of the proper authorities, and to recommend an appropriation of $200,000 for beginning the work.

Grosse Point Channel is located in the collection district of Detroit, Mich. Windmill Point light-house and Grosse Point light-ship are in the close vicinity.

Money statement.

Amount (estimated) required for completion of proposed project	$553,300
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

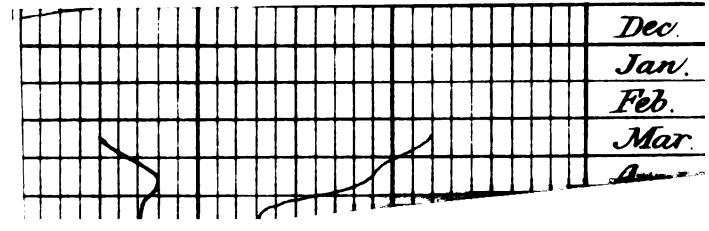
J J 16.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN

Originally the channel at Lime Kiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depths being much affected by the direction and force of the wind.

As originally projected in 1874, the improvement at this point was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the original estimate was based upon this project.

In 1883 it was wisely determined to so modify the project as to secure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a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done.

In 1886 this was further modified to the end that the width of the channel should be increased to 400 feet by removing an additional 100 feet from the western (American) side.

Only one contract has been in force during the fiscal year, namely, with Dunbar & Sullivan, dated October 15, 1886. The operations in progress at the date of the last Annual Report were continued under this contract until September 15, 1887, when they were stopped by the exhaustion of the appropriation.

The work done during the fiscal year consisted in the removal of 1,085 cubic yards of solid rock and 10 cubic yards of loose rock.

The total amount of work done under the above contract (appropriation of $37,500 made by act of August 5, 1886) was as follows:

	Cubic yards.
Solid rock removed	5,883
Loose rock removed	119

At a cost of $35,417.

The total amount of work done on this improvement to the 30th June, 1888, is as follows:

Area drilled, blasted, and completed	square feet	883,853
Solid rock removed (scow measurement)	cubic yards	2,632
Solid rock removed (bank measurement)	do	78,406
Loose rock removed	do	1,052

In order to complete the improvement to a width of 400 feet according to the present project, 14,465 cubic yards of solid rock and a small quantity of loose rock remain to be removed. The estimated cost of doing this is $130,500.

The improvement as it now stands has been completed to the full width of 300 feet as contemplated in the project of 1883, and but a comparatively small amount of material remains to be removed in order to render available an additional width of 50 feet under the project of 1886, for a 400-foot channel.

The estimated cost of the 400-foot channel was $1,374,500. The actual aggregate of the appropriations thus far made and expended is $572,500. The estimated cost of the work remaining to be done is $130,500, which will give as the actual cost of the 400-foot channel the sum of $703,000, or $671,500 less than the original estimate.

This fact encourages me to recommend, in the strongest terms I may properly use, the appropriation in one sum of the $130,500 required to complete the improvement. The result already accomplished is of incalculable benefit to the commerce passing this point, amounting last year to 38,125 vessels, having a tonnage of 18,864,250, including only so much of the purely Canadian commerce as passes both this point and the Welland Canal. If the remainder of the Canadian commerce were included the aggregate would be increased to more than 40,000 vessels, with a tonnage of more than 20,000,000, or fully six times the entire commerce crossing Detroit River (both ways) by rail.

The improvement is truly national in character. Not a grain of wheat brought from Minnesota or Dakota to New York; not a pound of iron ore brought to Ohio or Pennsylvania; not a ton of coal from Lake Erie to the upper lakes but shares it advantages.

This work is located in the collection district of Detroit, Mich. The nearest port of entry is Detroit. The nearest light-house is Mammy Judy, about 5 miles distant.

Money statement.

July 1, 1887, amount available	$8,991.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,830.75
July 1, 1888, balance available	160.52
Amount appropriated by act of August 11, 1888	130,500.00
Amount available for fiscal year year ending June 30, 1889	130,660.52

Number and tonnage of United States vessels which passed through Detroit River during the season of 1887.

Number of vessels	38,125
Tonnage	18,864,250

Statement showing the number of loaded cars which crossed Detroit River during the season of 1887.

East-bound	153,678
West-bound	131,983
Total	285,661
Tonnage (at an average of 12 tons to the car)	3,427,932

APPENDIX K K.

IMPROVEMENT OF HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA—IMPROVEMENT OF SANDUSKY RIVER.

REPORT OF MAJOR L. COOPER OVERMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky City Harbor, Ohio.
5. Sandusky River, Ohio.
6. Huron Harbor, Ohio.
7. Vermillion Harbor, Ohio.
8. Black River Harbor, Ohio.
9. Rocky River, Ohio.
10. Cleveland Harbor, Ohio.
11. Fairport Harbor, Ohio.
12. Ashtabula Harbor, Ohio.
13. Conneaut Harbor, Ohio.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, July 10, 1888.

GENERAL: I have the honor to transmit herewith the annual reports of the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

K K 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

The harbor of Monroe, Mich., is situated at the extreme westerly bend of Lake Erie, about 1½ miles west of the old mouth of the Raisin River and about 3½ miles from the town of Monroe.

This improvement was commenced in the year 1835, at which time the Raisin River was considered an important stream and Monroe was a place of some prominence. The plan of improvement consisted in straightening the river and making direct connection with Lake Erie by a canal 4,000 feet long and 100 feet wide through a sand peninsula,

A description in detail of the operations heretofore carried on for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

OPERATIONS DURING THE FISCAL YEAR.

The act approved August 5, 1886, appropriated $2,000 for repairs for this harbor. This sum, excepting balance of $371.94, had been expended by end of year 1886 in repairs. During June and July, 1887, the balance was expended in minor repairs to piers by hired labor and purchase of material in open market. No other work for improving this harbor was practicable during balance of the fiscal year for want of funds. The piers and revetment of canal are still in very bad condition, and portions of the piers below ordinary low water are badly rotted and gone. Dredging is also needed at various points to restore the usual average depth of 13 feet.

General and thorough repairs, according to previous estimates, will cost about $20,000, but such an expenditure has not heretofore been deemed necessary, as the commerce seeking this harbor was insignificant. Immediate repairs to the amount of $5,000 to $6,000 are very badly needed and should be made at once.

As the business at this harbor has increased considerably in the last two years, with prospect of still greater increase, general and thorough repairs to piers should be undertaken at once and considerable dredging done; and the whole of the estimated amount for existing project, viz, $20,000, could be profitably expended in one season's work in addition to the $6,000 needed for immediate repairs.

The whole amount appropriated for this harbor to date has been $215,515.27, all of which has been expended.

PRESENT CONDITION OF THE HARBOR.

An examination of the channel of this harbor was made in June, 1887, extending from the docks at Monroe to the 14-foot curve in the lake. The soundings showed some slight changes in the depth of channel from lake to Monroe, and the bar in lake beyond end of south pier had increased somewhat, having a least depth of 8.8 feet for a short distance.

The following depths were found in June, 1887:

Least depth of water—	Feet.
In channel entering the harbor	13.3
In United States Canal	11.4
In channel from United States Canal to City Canal	9
Through the City Canal	13
In channel from City Canal to docks	9
In channel in front of lower docks	9
In channel in front of upper docks	8

The harbor of Monroe is in the collection district of Detroit, Mich.

There is a fixed white light of the fourth order on the outer end of the west pier. The nearest work of defense is Fort Wayne, 30 miles distant.

During the eleven months ending May 31, 1888, the amount of revenue collected was $37.50.

The imports, consisting of cedar posts and poles and fish, amounted in value to $5,000.

There were no exports.

Fifty-one vessels, with an aggregate tonnage of 10,100 tons, entered, and fifty-one vessels, with an aggregate tonnage of 10,100 tons, cleared during the eleven months ending May 31, 1888.

Of the vessels entering or clearing the largest cargo was 14,000 poles and the deepest draught was 10 feet.

Money statement.

ıt appropriated by act of August 11, 1888	$5,000.00
unt (estimated) required for completion of existing project	15,000.00
unt that can be profitably expended in fiscal year ending June 30, 1890	21,000.00

nitted in compliance with requirements of sections 2 of river and rbor acts of 1866 and 1867.

K K 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

› city of Toledo, Ohio, is situated at the mouth of the Maumee . The Maumee River empties into Maumee Bay at a point, by ıf the channel, about 7 miles from the deep water of Lake Erie. ıistory of the operations carried on in past years for the improve- of this harbor will be found in the Annual Reports of 1880, 1881, 883.

› present channel, which is 250 to 300 feet wide at the angles, with th of from 15 to 17 feet at ordinary low water, has been obtained venteen appropriations averaging $41,650 and an annual average ıditure of about $41,320. It is probable that appropriations will to be made for some years to complete this channel and a contin- nnual expenditure of about $20,000 made to maintain the depth at nt required or until the straight channel is available.

› project for the old channel as adopted in 1872, and amended in so as to gain increased depth, provides for widening to 250 feet at ce and 200 feet at bottom and deepening to 16 feet at low water atural channel through Maumee Bay.

ıgress by two appropriations has sanctioned the project for a ıight channel" from mouth of Maumee River to deep water in Lake and by act of August 5, 1886, the location was to be "along such as the Secretary of War might approve.

OPERATIONS FOR THE FISCAL YEAR—OLD CHANNEL.

ring the fiscal year no work was in progress, there being no funds able.

the close of the fiscal year 1888, the condition of the old channel ıs follows:

st. From the Toledo City docks to the Manhattan Range, a good channel, with a least depth of 18 feet.

ond. The Middle Range, 576 feet long, had a width of from 160 to eet, and least depth of 15 feet in dredged channel.

ird. The Phenstock Range, 5,055 feet long, had a width of from o 220 feet (the latter width at the turns), and least depth of 16 feet annel.

urth. The Can Range, 11,580 feet long, with a width of from 120 to eet at turns, and least depth of 16 feet in dredged channel.

th. The Turtle Island Range, 9,790 feet long, with width of from et across bars to 180 feet, and least depth of 16 feet in dredged nel.

:th. The Outer Range, 7,800 feet long, with width of from 60 feet 0 feet, with least depth of 15.8 feet.

Full depth of 16 feet required and increased width varying from 140 to 300 feet.

All soundings referred to the zero of the gauge. Increased width and depth are needed and the want of same is complained of. Complaints have been made by vessel men and owners during the season for want of greater depth in channel.

A comparison of the condition of channel with that of close of 1887 shows a decrease in depth and a slight loss in average width of channel, which would indicate that with the removal of annual deposits it will be necessary to provide for the removal of over 200,000 cubic yards for some seasons yet in order to secure the full depth and full width proposed by the improvement of the old channel.

The total amount appropriated to close of fiscal year for old channel for this harbor since 1866 has been $714,046.91, all of which has been expended. The estimated cost of the project for old channel, viz, a channel with a least depth of 16 feet at ordinary low water and 250 feet in width at surface, was $570,000. Of this amount $519,346.91 to close of fiscal year had already been appropriated and expended.

The balance of $50,000 originally estimated and yet to be appropriated will not complete the project, mainly from the lengthened period consumed in doing the work for want of adequate apppropriations.

The estimate made in 1872 (amended in 1880) contemplated large appropriations, and consequently limited contingencies, whereas the appropriations have been small, requiring thirteen years to obtain $519,000, and contingent expenses and the annual removal of the deposits of each winter and spring have been repeated for thirteen years, so that they have absorbed at least $100,000 of the original estimate. It will, therefore, require at least $150,000 to complete the projected improvement of the natural channel through Maumee Bay.

The amount of commerce to be benefited is very large, and continues to grow in importance. Previous reports have given valuable statistics on this subject, to which attention is invited.

TOLEDO HARBOR, OHIO—"STRAIGHT CHANNEL."

For a history of this project and the work done to the close of fiscal year ending June 30, 1887, see Annual Reports of 1884, 1885, 1886, and 1887.

OPERATIONS DURING THE FISCAL YEAR—"STRAIGHT CHANNEL" IMPROVEMENT.

The act approved August 5, 1886, contained the following with reference to Toledo Harbor, Ohio:

> Continuing improvement of the Maumee River by a straight channel along such line as may be approved by the Secretary of War, $112,500, and the balance of the $25,000 heretofore appropriated, are hereby made available for clearing the old channel.

This necessitated additional examination of the locality in order to determine which line to recommend for the action of the Secretary of War. Authority was asked for and obtained to make such examination. A special report of this examination with recommendation was made, and this report was referred to the Board of Engineers, U. S. Army, for examination and report.

Under date of April 12, 1887, the Board of Engineers submitted their report, and recommended a line for straight channel, which report

was recommended for approval by the Chief of Engineers, U. S. Army, and approved by the Secretary of War under date of April 27, 1887.

The approved line differs in location and direction from all the lines heretofore suggested. A copy of the report of the Board of Engineers, with letter of instruction, was received May 6, 1887. Preparations were at once made for commencing the work in accordance with instructions and the report of the Board of Engineers.

Proposals were invited, and after three lettings acceptable bids were received, and two contracts were executed, one with George Kellogg, of Fulton, N. Y., for 423,000 cubic yards, more or less, at 12 cents per cubic yard, scow measurement, and one with French & Rooney, of Toledo, Ohio, for 370,000 cubic yards at 15 cents per cubic yard, scow measurement.

Active operations were commenced under these two contracts during the last week of July, 1887, and continued with four dredges until November 19, 1887, when work was suspended for the winter.

Operations were resumed April 25, 1888, and have been continued until the present date. About 428,913 cubic yards were excavated and removed under the two contracts during the fiscal year ending June 30, 1888. This amount is about three-fifths of the quantity to be removed under said contracts, which, when completed, will exhaust the appropriations of 1886. The whole amount to be removed under these two contracts is about 38 per cent. of the total quantity estimated to make the excavation a long line of straight channel; and as the channel will be of little use until excavated to full width and depth for the entire length it is for the best interests of all that it should be done as rapidly as possible. Hence large appropriations should be made annually until the new channel is completed. The revetment and protection of said channel will then have to be accomplished.

At least $500,000 could be profitably expended during the fiscal year ending June 30, 1890, on this project.

There have been thus far two appropriations for the "straight channel," viz, that of July 5, 1884, of $25,000, of which $15,653.09 was expended in connection with the line selected by Colonel Wilson (the balance transferred to old channel), and the appropriation of August 5, 1886, amounting to $112,500; making a total of $128,153.09, of which sum $84,730.20 had been expended at the close of the fiscal year ending June 30, 1888.

The estimated cost of completing the straight channel is calculated on the basis of cost heretofore estimated for other lines, since the Board of Engineers in adopting the approved line made no new estimate, and left the question of protection of the dredged channel to be determined by future observation and experience.

The approximate estimate on said basis is $1,875,000, requiring, therefore, further appropriations amounting to $1,762,500 to complete.

All funds available July 1, 1888, are pledged to contractors for dredging during the present year, leaving nothing for further work.

An abstract of contracts for straight channel work is transmitted herewith.

Toledo is in the collection district of Miami. There is a fixed white light of the fourth order on Turtle Island and three sets of range-lights for parts of the channel.

The amount of revenue collected during the eleven months ending May 31, 1888, was $30,276.28

The imports, consisting of general merchandise, tin-plate, hardware, lumber, etc., amounted in value to $171,544.

The exports, consisting of wheat, corn, coal, timber, staves, etc., amounted in value to $635,920 for the eleven months ending May 31, 1888.

Fifteen hundred and forty-six vessels, with an aggregate tonnage of 417,040 tons, entered, and 1,540 vessels, with an aggregate tonnage of 424,324 tons, cleared during the eleven months ending May 31, 1888.

Of the vessels entering, the largest cargo was 2,200 tons of iron ore, and the deepest draught was 15½ feet. Of the vessels clearing, the largest cargo was 2,000 tons of iron ore, and the deepest draught was 15½ feet.

Money statement.

TOLEDO HARBOR, OHIO, STRAIGHT CHANNEL.

July 1, 1887, amount available		$109,178.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$49,517.89	
July 1, 1888, outstanding liabilities	16,237.87	
July 1, 1888, amount covered by existing contracts	42,400.00	
		108,155.76
July 1, 1888, balance available		1,022.89
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		151,022.89
Amount (estimated) required for completion of existing project		1,612,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

TOLEDO HARBOR, OHIO, OLD CHANNEL.

Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	45,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contracts for improving harbor at Toledo, Ohio, in force during the fiscal year ending June 30, 1888.

(1) Contract with George Kellogg, of Fulton, N. Y., dated July 19, 1887, for dredging 423,000 cubic yards, more or less, of material from Maumee Bay, along line of "straight channel," at Toledo Harbor, Ohio.

Rate paid, 12 cents per cubic yard, scow measurement.

Work in progress. Time for completion of contract, September 30, 1888.

(2) Contract with French & Rooney, of Toledo, Ohio, dated July 25, 1887, for dredging 370,000 cubic yards, more or less, of material from Maumee Bay, along line of "straight channel," at Toledo Harbor, Ohio.

Rate paid, 15 cents per cubic yard, scow measurement.

Work in progress.

Time for completion of contract, December 15, 1888.

K K 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

Port Clinton, Ohio, is situated at the mouth of the Portage River, a stream which rises in the northwestern part of Ohio and empties into Lake Erie.

A history of the operations heretofore carried on for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The present project, adopted in 1875, provides for a pile revetment, 967 feet long, running from the north shore of Portage River, opposite the town, out into the lake, in a direction north 57 degrees east. This revetment then inclines towards the north and extends 301 feet further, when a pile dike commences which will be prolonged a total distance of 1,200 feet out to a depth of 10 feet at the ordinary level of the lake.

Parallel to this and 200 feet from it is an east pile-pier which will be about 2,600 feet long, its inner end resting on the south shore of the river. This east pier will be a simple pile structure of 2,450 feet; the outer 150 feet will be a strong pile-dike 12 feet wide. A channel 10 feet deep will be dredged between the piers.

OPERATIONS DURING THE FISCAL YEAR.

The river and harbor bill approved August 5, 1886, appropriated "for improving harbor at Port Clinton, Ohio, by repairs to existing works," $2,000.

Proposals were received May 23, 1887, and a contract for making the necessary repairs to the extent of available funds was executed with John Stang, of Lorain, Ohio, under date of June 23, 1887.

Material was delivered and actual operations were completed in October, 1887. The funds were all expended in repairs, but much remains to be done to place the piers in good condition.

Dredging is also needed.

The whole amount appropriated for this harbor to date has been $48,000, all of which sum has been expended to close of this fiscal year.

The estimated cost of the present project, as submitted in 1875, was $122,000, a revised estimate being $90,000. The project contemplated the extension of the pier and revetment to the 10-foot depth in lake at ordinary stage of water.

The sum of $48,000 has been appropriated and expended up to the close of the fiscal year ending June 30, 1888, but as the commerce of Port Clinton is small, and prospects for much increase in the near future are not great, it is doubtful whether the expenditure of the remaining $42,000 for the completion of the proposed project, under the revised estimate, would be advisable.

If it is decided to continue the improvement as proposed, the sum of $20,000 can be expended during the period ending June 30, 1890, in prolonging the pier and revetment; otherwise the sum of $5,000 could be expended in completing repairs and in dredging.

An examination of the channel of this harbor was made July 5, 1888.

The depth between the pier and revetment, wherever the same are parallel, was found to be good, averaging from 9 feet to 14½ feet; but at the turns, where there is a divergence, the depth was only $7\frac{6}{10}$ feet. A bar has formed in lake beyond end of piers, with least depth of $8\frac{1}{10}$ feet on crest of bar.

The river and harbor bill approved August 5, 1886, contained the following reference to this harbor:

For the purpose of acquiring the title to the land adjoining the inner end of the west pier built by the United States for the improvement of the harbor at Port Clinton, Ohio, the Secretary of War shall negotiate with the owner or owners of the land for the purchase thereof at a reasonable price, to be approved by Congress, and if an agreement as to price cannot be made with the owner then the value of same shall be ascertained in the mode provided by the laws of Ohio for condemnation of lands for public uses in that State, the result of said proceedings of condemnation, if taken, to be reported to the next Congress for its approval.

Considerable correspondence passed between the owner of the land in question and the engineer officer in charge of the harbor, resulting in the owner offering to take $2,500 for the beach.

An abstract of contract is transmitted herewith.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest work of defense is Fort Wayne, Mich., 60 miles distant, and the nearest lighthouse is at Green Island, 10 miles distant.

No report of the commerce of this harbor was received from the collector of customs for the fiscal year ending June 30, 1888.

The following statistics, comprising collector's report for the fiscal year ending June 30, 1887, are submitted:

Fifty-four vessels, with an aggregate tonnage of 2,896 tons, entered this harbor from other districts, and forty-eight vessels, with an aggregate tonnage of 2,560 tons, cleared this harbor for other districts.

Of the vessels entering or clearing the largest cargo was 400,000 feet of lumber and the deepest draught was 10 feet.

Money statement.

July 1, 1887, amount available	$1,960.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,960.66
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving harbor at Port Clinton, Ohio, in force during the fiscal year ending June 30, 1888.

Material.	Rate.	Material.	Rate.
White oak ..... per M feet, B. M..	$39.00	Brush ..... per cord..	$3.50
Piles ..... per linear foot..	.35	Drift-bolts ..... per pound..	.03
Filling stone ..... per cord..	5.50	Spikes ..... do....	.04
Riprap stone ..... do ..	5.50	S. and W. bolts ..... do....	.04

Contract with John Stang, of Lorain, Ohio, dated June 23, 1887, for repairs to pier and revetment at Port Clinton Harbor, Ohio.

Contract time for completion extended to September 30, 1887. Contract completed and closed.

K K 4.

IMPROVEMENT OF SANDUSKY CITY HARBOR, OHIO.

Sandusky Bay empties into Lake Erie about 40 miles from its western extremity. It is a natural harbor, containing an area of about 22½ miles, with a depth of from 8 to 12 feet, protected on the north and northwest from the gales of the lake by a long, narrow peninsula, and on the northeast by what is known as Cedar Point.

A full description of the operations carried on in past years for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The project adopted in 1880 provides for a channel 200 feet wide and 15 feet deep through the outer bar and in the bay up to within 50 feet of the line of docks, and then parallel to the docks, with a width of 100 feet and depth of 15 feet.

The revised project proposes to shorten and improve the present channel by a straight channel cut from the north end of Cedar Point to the east end of the existing channel in front of city.

OPERATIONS DURING THE FISCAL YEAR.

The act approved August 5, 1886, made available $15,000 for the fiscal year ending June 30, 1887.

A project for the expenditure of these funds was submitted and approved, and proposals invited for doing the dredging. A contract was executed with Carkin, Stickney, and Cram, of East Saginaw, Mich., dated October 15, 1886, for dredging 90,000 cubic yards, more or less, at 15 cents per cubic yard, scow measurement.

Operations were resumed in April, 1887, and continued until the close of the year. The progress was very slow, and by June 20, 1887, when contract should have been completed, only about one-eighth of the required dredging had been done. The contractors applied for and obtained an extension of time in which to complete their contract until July 30, 1888.

Operations were resumed May 10, 1888, and have been continued until the present date. The progress under this contract from the beginning until date has been very slow.

At the end of the fiscal year there was an available balance of $649.13; work was in progress under the contract of October 15, 1886, extended as to time of completion to July 30, 1888.

At the close of the fiscal year ending June 30, 1888, there was a fairly good channel, with least depth of 14 feet, but not of full width through all the ranges. The condition of the channel was not so good as at the close of the season of 1887, showing no advance in the proposed improvement over the annual filling in. The outer bar needs most attention where the full width has as yet not been obtained on account of the small appropriations. For the various reasons given no progress toward the improvement of this harbor was practicable during the fiscal year ending June 30, 1888.

The total amount appropriated for this harbor to close of fiscal year has been $270,080, of which sum $263,715.47 has been expended.

It is estimated that $20,000 will be required to complete this project, the whole of which can be expended during the fiscal year ending June 30, 1890. With increase of commerce at Sandusky an increase to 16 feet in depth of channel is needed to make it correspond with other important harbors on Lake Erie, and with depth now carried through the Saint Clair Flats Canal. This increased depth, it is estimated, would cost $61,000 additional, making $81,000 required for this harbor, of which sum $60,000 can be expended by the close of the fiscal year ending June 30, 1890. Like all the lake harbors where a dredged channel is the method of improvement, the annual expenditure must be a larger one to maintain the channel and remove the material which the winter and spring storms wash into the channel.

The total amount expended on this harbor during the fiscal year ending June 30, 1888, was $7,388.39.

The river and harbor bill which passed both branches of the Forty-ninth Congress but failed to receive the signature of the President

contained an appropriation for making a straight channel from east end of the existing channel in front of city docks to the north end of Cedar Point.

This appropriation was renewed in the river and harbor bill which passed the House of Representatives of the Fiftieth Congress. The sum of $40,000 is allotted for beginning the work. All of this sum can be profitably expended in one working season in dredging, and as the new channel will not be of any use till completed to full width and depth the balance of the estimated amount to make the excavation, viz, $56,712, should be allotted in one appropriation, and could be profitably expended during the fiscal year ending June 30, 1890.

For a history of this project for making a straight channel and detailed estimate of cost, see Annual Report of the Chief of Engineers for 1887, pages 2303 and 2304, and pages 2335 to 2341.

An abstract of contract is transmitted herewith.

Sandusky City Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range-lights within the bay. Fort Wayne, below Detroit, is the nearest work of defense.

No report of the commerce of this harbor having been received from the collector of customs for the fiscal year ending June 30, 1888, the following statistics, received for the fiscal year ending June 30, 1887, are submitted:

The amount of revenue collected was for the district $5,019.72, and for the port of Sandusky, $4,686.73.

The imports, consisting of fish, round timber, wood, etc., amounted in value to $53,640 for the district and $47,316 for the port of Sandusky.

The exports, consisting of grain, coal, produce, etc., amounted in value to $239,587.27 for the district, and for the port $165,140.27.

The number of vessels entering was, for the district, 3,585; aggregate tonnage, 571,831 tons; for the port of Sandusky, 2,619, with tonnage of 407,087 tons. The number of vessels clearing was, for the district, 3,605; aggregate tonnage, 569,359 tons; for the the port, 2,611, with an aggregate tonnage of 407,849 tons.

Of the vessels entering or clearing, the largest cargo was 2,589 tons of iron ore, and the deepest draught was 15½ feet.

Money statement.

July 1, 1887, amount available		$12,337.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,972.81	
July 1, 1888, outstanding liabilities	2,565.40	
July 1, 1888, amount covered by existing contracts	3,150.00	
		11,688.21
July 1, 1888, balance available		649.13
Amount appropriated by act of August 11, 1888		40,000.00
Amount available for fiscal year ending June 30, 1889		40,649.13
Amount (estimated) required for completion of existing project		66,712.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		66,712.00

Submitted in compliance with the requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving harbor at Sandusky City, Ohio, in force during the fiscal year ending June 30, 1888.

Contract with Carkin, Stickney & Cram, of East Saginaw, Mich., for dredging 93,000 cubic yards, more or less, of material from channel through Sandusky Bay. Contract dated October 15, 1886.

Rate paid, 15 cents per cubic yard, scow measure.

Work in progress. Contract time for completion extended to July 30, 1888.

SURVEY OF SANDUSKY HARBOR, OHIO, WITH A VIEW TO A STRAIGHT CHANNEL FROM THE NORTH END OF CEDAR POINT TO THE EAST END OF THE EXISTING CHANNEL IN FRONT OF THE CITY.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, February 2, 1887.

GENERAL: I have the honor to transmit herewith, in separate package, a chart (tracing) of a portion of Sandusky Bay, Ohio, together with profiles* (tracing) along line of proposed new channel, and to submit the following report of a survey made in accordance with act of Congress approved August 5, 1886.

The port of Sandusky, Ohio, is situated on Sandusky Bay, which bay empties into Lake Erie about 40 miles from the western end of the lake. Sandusky Bay is a natural harbor, containing an area of about 22½ miles, with a depth of from 8 to 12 feet. It is protected on the north and northwest by a narrow peninsula, and on the east by another point of land known as Cedar Point. Sandusky River is the only stream of any size which empties into the bay, which it does at its southwest extremity, some 14½ miles from Cedar Point.

The channel by which vessels reach Sandusky City docks is the result of plan for improvement adopted in 1864, which plan has been amended from time to time, until now it provides for dredging and maintaining a channel through the bar outside of Cedar Point and through the bay to within 50 feet of the line of the city docks and then parallel to the line of docks. The channel through the bar and bay to be 200 feet wide, while that parallel to the docks is 100 feet wide; and all to have a depth of 15 feet.

By this channel it is nearly 4⅓ miles from deep water of the lake to city docks.

This route was selected for improvement in 1864, when the commerce of Sandusky was small as compared with its present commerce, whilst the commerce of Sandusky River was sufficiently large at that time to influence the route selected for improvement, and when lake vessels did not require over 13 feet channel depth.

It was the route at that date which could be improved for the least expenditure of funds and promised the earliest relief to the commerce which entered the bay. For some years past, however, much objection has been made to the existing channel. It is crooked and difficult for vessels to navigate, and requires three sets of range-beacons to enable a vessel to follow it. The want of sufficient depth is also complained of. In 1882 an increase of channel depth to 16 feet was recommended by the engineer in charge, and an estimate of $61,000 submitted for the additional dredging required; but since this latter date the commerce of Sandusky has increased so rapidly, and the increased and increasing draught of lake vessels make 17 feet depth of channel necessary. This additional depth will cost at least $50,000 more, making a total of $111,000 necessary to make the existing channel of adequate depth for present demands of commerce.

As the commerce of Sandusky City grew in importance, the question as to the best line for the portion of the channel through Sandusky Bay (*i. e.*, inside of Cedar Point) was discussed, and especially so of late years. As far back as 1873 the *straightening* of the route by cutting a new channel through "Horse Shoe Shoal," or the middle ground, was reported upon by the then engineer in charge.

* Not printed.

This question has not ceased to be agitated by the citizens or Sandusky, and, with the knowledge that additional appropriation would be necessary for the increased depth required, they had an examination made at their own expense in the fall of 1884 to determine the approximate cost of straightening the present channel by cutting through the middle ground, thereby making a direct route from the city docks to Cedar Point.

The examination developed the fact that a very favorable line existed for such a direct route and with comparatively little cutting to make 17 feet depth. A committee of the citizens of Sandusky presented the matter to Congress during the session of 1885, but the failure to pass a river and harbor bill that year prevented any definite action being taken.

The effort was renewed in 1886, and resulted in a survey being authorized by act of Congress approved August 5, 1886. The act provides for an examination or survey and the cost of improvement to be estimated at "Sandusky Harbor with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city."

In compliance with instructions from the office of the Chief of Engineers, U. S. Army, dated September 27 and October 28, 1886, I made a preliminary examination of the proposed line, and, under date of November 8, 1886, I submitted a report of said personal examination, with estimate of cost of a survey, in which report I recommended "the project worthy of improvement, and that it was called for by the present and prospective demands of the commerce of Sandusky."

The report was approved and a survey ordered to be made. A field party under charge of B. H. Colby, assistant engineer, made the survey from the surface of the ice which then covered the bay. The work was done with accuracy and despatch, and Mr. Colby displayed commendable energy and push in the work under his charge.

The route for the proposed straight channel being so definitely designated in the act authorizing the survey, it was only necessary to locate the line to make the required soundings and to make an examination of the character of the bottom through which the cutting would have to be made to enable the "estimate of cost of improvement" to be determined. The line was found to be 9,465 feet in length, and joins the existing channel outside of Cedar Point by an easy curve and unites with the channel in front of city docks by an easy curve. The survey demonstrated a very favorable line, with comparatively small amount of cutting to make a channel of 17 feet depth.

About 25,000 soundings were taken and 75 borings were made. The maximum cut to gain 17 feet was 12.4 feet, the minimum cut 4.4 feet, the average cut being 7.1 feet.

The borings to determine the character of the material were made to 18 feet below the surface of the water, and indicated that (beginning at the east end of the channel parallel to the city docks) for the first 3,500 feet of the route the material was mud overlying a clay bottom—the clay appearing at about 16 feet below surface of water—beyond this no clay was found at a depth of 18 feet or less; for the next 1,000 feet mud only was found; then a mixture of mud and sand for the next 2,000 feet. At 6,450 feet from the beginning point a bed of quicksand was struck at a depth of 17 feet, with coarse sand overlying it and mud beneath. The bed varied in thickness from 1 foot to 6½ feet, extending the remainder of the route and for full width for which borings were carried, viz, 260 feet. The mud was found under it in all places at from 16 to 17 feet

below water surface. The bed of quicksand gave indications of ending at the deep hole near Cedar Point, in which a depth of from 18 to 30 feet exists.

The material along the entire line is therefore favorable for easy dredging.

An examination of the tracings submitted with this report shows the great advantage, both in directness and length, of the proposed new route, the saving in distance from the city docks to Cedar Point being 6,076 feet in 15,540 feet, or nearly 40 per cent.

As the proposed route is a direct channel, all the disadvantages to navigation resulting from "turns" and "bends" will be obviated, and being a straight channel, the liability to fill in during the winter and spring will be very much less. The annual amount of dredging for maintenance will therefore be much less and the line a shorter one to maintain. Being well protected on the east side by Cedar Point, the unprotected cut will not be so liable to damage from storm, especially from northeast gales. The new route from Cedar Point into the city docks will require but one set of range-marks for vessels to navigate it, and one of these it will have already prepared in the city clock-tower, a well-defined, permanent, and visible beacon by day or night, in direct range of the proposed channel.

With regard to "liability to fill," the new route has equal if not superior advantages over the existing one.

There are two well-defined currents in Sandusky Bay, produced in part from the outflow from Sandusky River. One sweeps along in front of the city docks and enters the lake by the eastern channel (east of the middle ground). The other passes the south of Johnson's Island and enters the lake by the west channel. Between these two channels lies the Horse Shoe Shoal or middle ground.

As the proposed new channel follows very nearly the route of the eastern current, it is expected that said current will aid materially in maintaining the depth of channel along the new route after it has once been obtained.

Therefore, while I believe that *any* unprotected channel through Sandusky Bay will gradually fill up without annual dredging, it is thought that the proposed straght channel will be as little liable so to do as the any other, for reasons already stated.

Hence the question of protecting the channel, which may ultimately have to be done, does not enter into this discussion, since it is a detrimental factor in the existing route and in all routes, but when considering this factor the shortest route must have the advantage.

Further, the protection of the cut should not be decided until actual results shall determine the annual cost to maintain the unprotected cut by dredging and what kind and how much is needed, as it is thought that a percentage as low as 3 per cent. on the cost of any method of protection will pay for the annual cost of dredging.

To make a channel 200 feet wide at bottom and 17 feet deep at low water along the route designated, which dimensions for the channel are the least that will accommodate the commerce of Sandusky, the following estimate is submitted:

Excavation, removal, and deposit of 538,000 cubic yards of material, measured in place, of which 6 per cent. approximately is clay, 56 per cent. approximately mud or mud and sand mixed, 22 per cent. approximately sand, 15 per cent. approximately quicksand, or say 628,000 cubic yards, scow measurement, at 14 cents per cubic yard	$87,920
Contingent expenses, say, 10 per cent	8,792
Total	96,712

The rate (of 14 cents) is deemed adequate, since the dredges when at work, for nearly the entire length of the line, will be protected from severe northeasterly gales by Cedar Point; the material to be removed is favorable for dredge work; and the average face of the cut a good one for such work. Further, the rate for dredging in Sandusky Bay of late years, for much less favorable work, more exposed and in small amounts, has been only 15 cents.

As the proposed straight channel has many advantages over the existing route, the only remaining objection to making a change will be the question of expense. To complete the project for existing channel it is estimated that $10,000 will be required; for the part from Cedar Point to city docks and to give 17 feet depth to said part of the channel will require at least $40,000 of the $111,000 heretofore shown as necessary for the entire length of channel.

We have therefore an estimate of $50,000 required to secure 17 feet depth and otherwise complete the existing channel from city docks to Cedar Point in accordance with plans recommended, admitting the necessity of the work.

The cost to make the new channel from city docks to Cedar Point will be then the difference between $50,000 and $96,712, viz, $46,712; a small amount when the advantages of the proposed new route are considered.

If the work along the proposed new route be undertaken and a channel 200 feet wide at bottom and 17 feet deep at low water be provided for, the same could be readily done in one season, if the whole amount estimated as necessary, viz, $96,712, be appropriated in one allotment, which would enable the work to be contracted for on favorable terms, and further work on the existing channel inside of Cedar Point could be dispensed with. Further, I am of the opinion that after said new channel is completed it can be maintained by dredging at an annual cost of, say, $5,000.

The following interesting statistics in regard to the commerce of Sandusky are submitted. They were kindly furnished me by Mr. John J. Finch, collector of customs, Sandusky, Ohio:

Amount of revenue collected during the calendar year 1886, $4,629.10.

Value of imports, consisting chiefly of fish, round timber, and wood, $40,231.65.

Value of exports, consisting chiefly of coal, grain, rope, and breadstuffs, $222,058.

Nine hundred and eighty-four vessels, with an aggregate tonnage of 237,461 tons entered, and 990 vessels, with an aggregate tonnage of 242,112 tons cleared, during the calendar year 1886.

The deepest draught of vessels entering or clearing was 15 feet 8 inches.

The largest cargo entering the port was 2,589 gross tons (iron ore), carried by the steamer *Onoko*, draught 14 feet 10 inches.

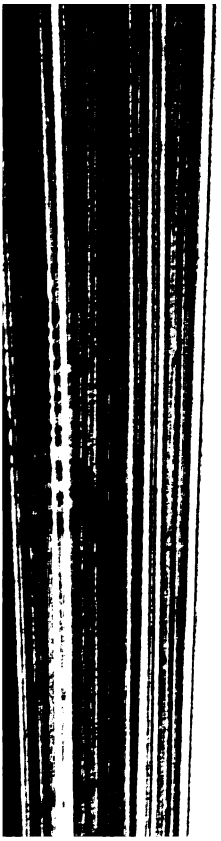
Among the vessels entering the port during the calendar year 1886 were the following:

Steamer *Nebraska*, cargo 1,500 tons flour, draught 14 feet 10 inches; schooner *John Shaw*, cargo 1,738 tons iron ore, draught 15 feet 8 inches; steamer *Magnetic*, cargo 2,086 tons iron ore, draught 14 feet 10 inches; steamer *Specular*, cargo 2,100 tons iron ore, draught 14 feet 10 inches; steamer *Onoko*, cargo 2,589 tons iron ore, draught 14 feet 10 inches; steamer *Ohio*, cargo 1,210 tons iron ore, draught 15 feet 3 inches; steamer *James Pickards*, cargo 1,708 tons iron ore, draught 14 feet 10 inches; schooner *Couch*, cargo 1,516 tons iron ore, draught 15 feet 4 inches; schooner *Susan Peck*, cargo 1,872 tons iron ore, draught 14 feet 10 inches; steamer *Chisholm*, cargo 1,934 tons iron ore, draught 15 feet; steamer *Nebraska*, cargo 1,000 tons copper and 500 tons pig-iron.

Among the vessels clearing were the following:

Schooner *John Shaw*, cargo 1,856 tons coal, draught 15 feet 8 inches; schooner *H. A. Kent*, cargo 1,600 tons coal, draught 15 feet 6 inches; steamer *Ohio*, cargo 1,200 tons coal, draught 15 feet 3 inches.

The foregoing is a partial statement of the business of the port with ports outside of this district; is partial only for the reason that many large and heavy-laden vessels clear for ports beyond this port, enter here, discharge and receive freight without making any report to the custom-house whatever.



Notably among such are the "Anchor Line" steamers, which clear from Buffalo, N. Y., through to Chicago, Ill.; one of said steamers coming usually into this port two or three times a week throughout the season.

I also append hereto an incomplete statement, but comprising the greater part of the business of this port with the ports within this district, the same being largely with the islands of the district, and consequently not reported to the custom-house, which is compiled from written statements furnished at my request by the owners and managers of the vessels engaged principally in such traffic, and is as follows:

Number of vessels entered from ports or places within the district, 1,514; tonnage of same, 158,977 tons.

Number of vessels cleared for ports or places within the district, 1,506; tonnage of same, 158,401 tons.

Number of tons of freight carried by the above-mentioned vessels during the year 1886, 106,399 tons.

Number of passengers carried by such only of the foregoing vessels as are principally engaged in the carriage of passengers, 89,727.

The following statistics show the increase of receipts and shipments by *lake* at the port of Sandusky, Ohio, of the two principal railroads terminating at said port, viz, the Baltimore and Ohio, and the Indianapolis, Bloomington and Western railroads, obtained from official sources:

RECEIPTS OF ORE BY THE BALTIMORE AND OHIO RAILROAD.

	Tons.
1882	49,123
1883	58,820
1884	107,704
1885	143,180
1886 (to October 18)	144,096

Receipts of flour in 1886, in transit, from Duluth to Belfast, Ireland, and London, England, *via* the Baltimore and Ohio Railroad and Baltimore, 29,000 barrels.

The Baltimore and Ohio Railroad also received in 1886, in transit, from Duluth to Europe, *via* Baltimore, to October 1, over 1,000,000 bushels grain.

SHIPMENTS OF COAL BY THE BALTIMORE AND OHIO RAILROAD.

	Tons.
1882	69,846
1883	100,895
1884 (year of strikes)	31,874
1885	96,637
1886 (to October 18)	117,742

The Baltimore and Ohio Railroad shipped by "Anchor Line" steamers, etc., in 1886, to October 1, over 5,000 tons merchandise.

The Indiana, Bloomington and Western Railway shipped in 1886, by lake, to New York and Eastern ports, to October 1, 1,750,000 bushels grain.

The grain shipments at this port by lake have for a number of years prior to 1886 been so light as to be scarcely worth mentioning.

Receipts of grain by the Baltimore and Ohio Railroad have been increasing ever since the new elevator was built.

As you are probably aware, the traffic above given has been mostly carried on in vessels of the large size.

It is hardly necessary to comment on the above, as the foregoing statistics plainly show the rapid increase, of late years, in the commerce of Sandusky, and give abundant evidence as to the prospective increase; and I earnestly recommend that a wide, straight, and easily-navigated channel, with full depth of 17 feet, may be authorized at an early day. The whole amount of the funds estimated for the improvement could be profitably expended during the fiscal year ending June 30, 1888.

Sandusky City Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range-lights within the bay.

Fort Wayne, below Detroit, is the nearest work of defense.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

K K 5.

IMPROVEMENT OF SANDUSKY RIVER, OHIO.

The Sandusky River rises in Richland County, Ohio, and after a very circuitous course empties into Sandusky Bay about 14½ miles from Cedar Point, where the bay empties into Lake Erie.

Fremont, the head of navigation, is 17 miles from the mouth of the river. It is a city of about 9,000 inhabitants, and the market place of a large and productive surrounding country.

A history of the work carried on in past years for the improvement of the river will be found in Annual Report for 1881.

The present project, adopted in 1880, provides for dredging a channel 100 feet wide and 9 feet deep through the various bars between the city of Fremont and the depth of 9 feet in Sandusky Bay.

The officer in charge, in his annual report for 1882, since which date there has been no work for the improvement of this river, writes as follows:

I am satisfied that but little difficulty will be experienced in keeping open at all times a good channel, with a depth of 9 feet, between Fremont and the mouth of the river; but the character of the materials comprising the outer bar is such that I deem it exceedingly doubtful whether the channel lately dredged through it will remain open for any length of time. I feel sure that no permanent improvement can be maintained without an elaborate system of dikes, the expense of which would not be warranted by the present limited commerce of the port.

OPERATIONS DURING THE FISCAL YEAR.

Balance of appropriation under act of August 2, 1882, at beginning of fiscal year was $628.47. No further appropriation has been made since. The amount on hand was too small to attempt any new work and was reserved for some contingency pending further appropriations.

No work was done during the fiscal year. There have been no complaints from vessel-men as to the condition of the channel, nor requests for additional improvements hence it is assumed that the river in its present condition answers all demands of the commerce navigating it.

The estimated cost of the present project is $44,000. Of this amount $21,500 has been appropriated. Ten thousand dollars can be expended during the period ending June 30, 1890.

Total amount appropriated for this river to date is $51,500, of which sum $50,871.53 has been expended.

The last river and harbor bill (act of August 5, 1886) made no appropriation of funds for this river, hence no work was done during the fiscal year ending June 30, 1888.

Fremont, the head of navigation, is in the collection district of Sandusky, Ohio. The nearest light-house is at Cedar Point, the entrance to Sandusky Bay.

Fort Wayne, near Detroit, Mich., is the nearest work of defense.

There were no revenue collections, no imports, and no exports for the fiscal year ending June 30, 1888.

Money statement.

July 1, 1887, amount available	$628.47
July, 1, 1888, balance available	628.47
Amount (estimated) required for completion of existing project	22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

K K 6.

IMPROVEMENT OF HURON HARBOR, OHIO.

The Huron River rises in the northern part of Ohio, and after a very circuitous course empties into Lake Erie about 10 miles east of Sandusky City.

For a history of the operations carried on in past years for the improvement of this harbor, see the Annual Reports of 1880, 1881.

The project for the improvement of this harbor, adopted in 1826, when the mouth of the river was closed by a sand-bar, and which project has been amended from time to time, as the demands of commerce called for an increased depth of channel, consists of parallel piers 140 feet apart, extending to the depth of 14 feet in the lake.

OPERATIONS FOR THE FISCAL YEAR.

The act approved August 5, 1886, made an appropriation of $3,000 for this harbor; dredging and repairs were recommended as the necessary work with this amount of funds, and the entire appropriation was so expended by the end of the year 1886. Only the most pressing of the necessary repair work could be done with the small appropriation of 1886. So much was needed that only "patching up" could be undertaken.

No work was done during the fiscal year ending June 30, 1888. The piers are in bad condition, and extensive repairs are needed; dredging also is badly needed.

The east pier is in very bad condition, and unless extensive repairs are soon made it is liable to fall into and close the channel.

An extension of the piers should be made to gain increased channel depth.

The entire amount appropriated to date (June 30, 1888) for this harbor has been $117,273.71, all of which has been expended and had given a good channel with 15 feet depth at low water until piers became so badly destroyed.

An examination of the channel of this harbor was made July 6, 1888, and showed a fair channel with least depth of $15\frac{7}{10}$ feet, and in such condition that a little work would secure a channel depth of 17 feet.

As Huron is one of the best natural harbors on Lake Erie, it will be proper, as the commerce of Huron increases, to extend the pier out to the 16-foot curve in the lake.

The Wheeling and Lake Erie Railroad Company have expended considerable for docks and slips at this harbor, with view to the shipment of coal, etc. The records of the custom-house, however, show that at present the amount of commerce to be benefited by further improvements at this harbor is small.

The estimated cost of renewing the superstructure of the piers was $22,000; $16,500 has been appropriated, but, owing to the extra repairs made necessary by the storms of 1885, 1886, and 1887, the estimate to complete the renewals should be $17,000, rather than the remaining balance of $5,500, which increased amount can be expended during fiscal year ending June 30, 1890, in rebuilding superstructure, repairing piers, etc.

Huron Harbor is in the collection district of Sandusky, Ohio. Fort Wayne, Mich., about 70 miles distant, is the nearest work of defense. There is a fixed white light of the fourth order on the outer end of the west pier.

During the eleven months ending May 31, 1888, the amount of revenue collected was $96.90.

The imports, consisting of iron ore, lumber, lath, salt, posts, etc., amounted in value to $66,320; and the exports, consisting of coal, wheat, etc., amounted in value to $77,530, during the eleven months ending May 31, 1888.

One hundred and twelve vessels, with an aggregate tonnage of 21,392 tons, entered; and one hundred and fifteen vessels, with an aggregate tonnage of 22,326 tons, cleared during the eleven months ending May 31, 1888.

Of vessels entering or clearing the largest cargo was 1,650 tons of iron ore, and the deepest draught was 13½ feet.

Money statement.

Amount appropriated by act of August 11, 1888	$6,000.00
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

K K 7.

IMPROVEMENT OF VERMILLION HARBOR, OHIO.

The Vermillion River rises in the northern part of Ohio and empties into Lake Erie about 20 miles to the eastward of Sandusky City.

A history of the operations carried on in the past years for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The project of improvement which was adopted in 1836, when there was a depth of less than 2 feet of water on the bar at the entrance, and which project has been amended from time to time as the requirements of commerce demanded deeper water, consists of parallel piers 125 feet apart, running out to a depth of 12 feet in the lake.

OPERATIONS FOR THE FISCAL YEAR.

The act approved August 5, 1886, appropriated $3,000 for this harbor, all of which, excepting the small balance of $308.18, had been expended by the end of the year 1886 in repairs to piers. This balance of $308.18 was expended during October, 1887, in minor repairs to piers. Both piers are in fair condition.

An examination of the channel of this harbor was made July 6, 1888, which showed that there was a good channel with least depth of $10\frac{7}{10}$ feet from lake to town landing.

The proposed project for this harbor provides for opening a channel 100 feet wide and 14 feet deep from lake to the lower end of the docks at Vermillion; this channel to be secured by removing about 2,000 cubic yards of rock and about 25,000 cubic yards of gravel, sand, shale, etc., at an estimated cost of $15,000. The piers need further repairs, estimated to cost $2,000, making a total of $17,000 for the project.

The sand is steadily encroaching around the ends of the piers into the channel, and to arrest its progress it will be necessary to extend the piers, say, 500 feet further into the lake, at a cost of about $70,000. With the present limited commerce of Vermillion, such an expenditure is not advisable.

As but $6,000 of the estimated $17,000 for proposed project has been appropriated, and all of it expended in urgent repairs, it is doubtful

whether anything but the keeping of the existing construction in good condition should be undertaken until an increase of commerce shall require an increase of channel depth.

The total amount appropriated for this harbor to June 30, 1888, is $117,942.32, all of which has been expended.

Vermillion Harbor is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier. Fort Wayne, Mich., 80 miles distant, is the nearest work of defense. During the eleven months ending May 31, 1888, the amount of revenue collected was $4.20.

The imports, consisting of lumber and fish, amounted in value to $50,000; and the exports, consisting mainly of hogs, amounted in value to $3,000 for the eleven months ending May 31, 1888.

Twenty vessels, with an aggregate tonnage of 4,278 tons, entered, and same cleared during the eleven months ending May 31, 1888.

Of the vessels entering or clearing, the largest cargo was 350,000 feet of lumber, and the deepest draught was 12 feet.

Money statement.

July 1, 1887, amount available	$308.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	308.18
Amount appropriated by act of August 11, 1888	1,000.00
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

KK 8.

IMPROVEMENT OF BLACK RIVER HARBOR, OHIO.

Black River, Ohio, is formed by two branches, nearly equal in size, which, rising in Lorain County, Ohio, and flowing northward, unite about 8 miles from the town of Lorain, where the river empties into Lake Erie.

A history of the operations carried on during the past years, whereby the depth at the entrance to this harbor has been increased from about 3 feet to at least 16 feet, will be found in Annual Reports of 1880 and 1881.

The project of improvement submitted in 1828, and amended from time to time, as the demands of commerce called for an increased depth in channel, consists of parallel piers 200 feet apart, running out from the shore on each side of the mouth of the river to a depth of 16 feet in the lake.

OPERATIONS DURING THE FISCAL YEAR.

The act approved August 5, 1886, appropriated $10,000 for this harbor.

As the storms of previous seasons had done considerable damage to both piers, especially the east pier, proposals were invited for repairing same as far as available funds would permit. A contract was executed with Stang & Gillmore, of Lorain, Ohio, dated October 11, 1886, for the necessary repairs.

Work was not commenced till November, 1886, and had to be suspended December 11, 1886, on account of snow and ice. Operations were resumed May 15, 1887, and were continued until the close of July, 1887, when the work was completed and appropriation exhausted.

The storms of the past year have done considerable damage to the piers; the east pier is so badly deteriorated as to require renewal above

low-water surface for about two-thirds of its length. Both piers are badly in need of renewal and extension.

The present project provides for prolonging the west pier 180 feet, and the east pier 120 feet, and of renewing about 200 lineal feet of superstructure at an estimated cost of $45,000. Of this amount $37,000 has already been appropriated, but unexpected repairs made and to be made will make it necessary to still provide about $30,000 for completion of the project, all of which can be expended during the fiscal year ending June 30, 1890, in prolonging the piers and renewing the superstructure.

The total amount appropriated for this harbor to June 30, 1887, is $220,138.73, all of which has been expended, and with which a good 16-foot channel has been obtained.

The commerce of this harbor is increasing, and it is therefore important that the extension of piers as proposed should be accomplished at as early a day as possible, to prevent a recurrence of the shoaling at the entrance of harbor.

The whole amount required ($30,000) should be appropriated in one allotment, and it could be profitably expended during the fiscal year ending June 30, 1890.

An abstract of contract is transmitted herewith.

Black River is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order at the outer end of the west pier. The nearest work of defense is Fort Wayne, Mich., 80 miles distant.

No report for the fiscal year ending June 30, 1888, of the commerce of this harbor having been received from the collector of customs, the following covering an earlier period, is submitted:

For the calendar year 1887, the imports, consisting of iron ore, lumber, limestone, etc., amounted in value to $939,854. The exports, consisting of coal, amounted in value to $614,895. Three hundred and one vessels, with an aggregate tonnage of 94,796 tons, entered, and three hundred and forty-two vessels, with an aggregate tonnage of 130,662 tons, cleared during the calendar year 1887.

Of the vessels entering or clearing during the fiscal year ending June 30, 1887, the largest cargo was 2,400 tons of iron ore, and the deepest draught was 15 3/12 feet.

Money statement.

July 1, 1887, amount available	$5,498.99
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,498.99
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract for improving harbor at Black River, Ohio, in force during the fiscal year ending June 30, 1888.

Contract with Stang & Gillmore, of Lorain, Ohio, dated October 11, 1886, for repairs, etc., to piers at Black River Harbor, Ohio.

Material.	Rate.	Material.	Rate.
White pine ... per M feet, B. M.	$31.90	Riprap ... per cord	$4.50
White oak ... do	34.90	Spike ... per pound	.04
Piles ... per linear foot	.34½	Screw and wrought bolts ... do	.06
Brush ... per cord	3.00	Drift-bolts ... do	.03
Filling stone ... do	5.00		

Contract time for completion extended to July 31, 1887.

Contract completed and closed.

K K 9.

IMPROVEMENT OF ROCKY RIVER, OHIO.

Rocky River rises in the northern part of Ohio, and flowing north empties into Lake Erie, about 5 miles west of Cleveland.

A history of the operations heretofore carried on at this place under various acts of Congress will be found in the Annual Reports of the Chief of Engineers for 1880 and 1881.

The violent storms of the springs of 1885, 1886, 1887, and 1888 did considerable damage to the pier at this harbor.

OPERATIONS FOR THE FISCAL YEAR.

Balance on hand at beginning of the fiscal year of appropriation under the act of June 14, 1880, was $119.31, and no further appropriation was made during the fiscal year. No work was done during the fiscal year for want of funds.

The mouth of Rocky River is not a port; it has no commerce, and any expenditure of funds for its improvement beyond necessary repairs to the existing pier is not deemed advisable.

The Cleveland harbor of refuge is only 5 miles distant. An appropriation of $3,000 for repairs is all that is required at present. The total amount appropriated for the river mouth to present date (June 30, 1888) is $39,000, of which sum $38,880.69 has been expended.

An examination of the river made in October, 1883, showed that there was a fair channel 150 feet wide, with least depth of 7 feet from lake to head of Island No. 1 inside the pier; all that the commerce of the river calls for.

The last river and harbor bill (act of August 5, 1886) made no appropriation for this harbor; hence no repairs were made during the fiscal year ending June 30, 1888, and this delay has increased the amount of repairs now necessary.

The nearest light-house is at Cleveland; the nearest work of defense is at Fort Wayne, 106 miles distant.

Money statement.

July 1, 1887, amount available	$119.31
July 1, 1888, balance available	119.31
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

K K 10.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

Cleveland, Ohio, is situated at the mouth of the Cuyahoga River. This river rises in the northern part of Ohio, and after a very circuitous course empties into Lake Erie. A description of the operations carried on in past years for the improvement of this harbor will be found in Annual Reports for 1880 and 1881.

The original project of improvement, adopted in 1825, when there was a depth of only 3 feet in the narrow and crooked channel at the entrance,

and which project has been amended from time to time as the demands of commerce called for an increased depth of water, provides for parallel piers 200 feet apart, running out to a depth of 16 feet in the lake. This project is completed.

In 1875, in accordance with an act of Congress, a plan was submitted for a harbor of refuge at this place.

This plan, which, after amendment by the Chief of Engineers, was approved by the Secretary of War, provided for an outer breakwater in a depth of about 5 fathoms, connected at its west end with the main shore. The entrance near the east end was to be protected by extending the pier at the mouth of the river.

This plan was further amended by project for an additional breakwater extending on the east side of the opening between the piers.

The shore-arm of the west breakwater starts from a point about 700 feet west of the extremity of the old bed of the Cuyahoga River and runs out into the lake in a direction nearly due north a distance of 3,130 feet.

The lake-arm, which is about parallel with the main shore, is 4,030 feet long, and at a point 200 feet from its eastern extremity a spur 100 feet long runs out at right angles, so as to break the force of the heavy sea rolling along the breakwater during westerly and northwesterly gales. All this portion was completed in December, 1883.

The proposed east breakwater under the *latest plan* begins at a point on the prolongation of the lake-arm of the west breakwater and 500 feet from it; extends eastward on this line about 3,500 feet, then inclines towards the shore and extends 2,000 feet in a depth of 26 feet of water, and having between its eastern end and the curve of 14 feet depth of water an entrance 2,300 feet wide.

For the history of this change in plan for harbor of refuge see Annual Reports of 1884, 1885, and 1886, and House Ex. Doc. No. 189, Fiftieth Congress, first session, copy herewith, which I request may be published with this report.

OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the fiscal year work was in progress under existing contracts for the east breakwater and for parapet on west breakwater.

The act approved August 5, 1886, relating to Cleveland Harbor, Ohio, reads as follows:

> Improving harbor at Cleveland, Ohio, on the last plan projected, $93,750, of which $30,000 are to be used in building a parapet on the existing breakwater, and the $100,000 now on hand to be available for work on the last plan.

A project for the expenditure of these sums was submitted and contracts for the work duly executed.

Under contracts with Messrs. L. P. and J. A. Smith, of Cleveland, Ohio, work was carried on during the entire season, they having applied for and obtained an extension of time in which to complete their contract of February 28, 1887, from June 1, 1888, to September 30, 1888. The foundation for 1,200 linear feet of breakwater under their contract of October 28, 1886, was completed August 15, 1887. The total amount of stone placed in the foundation was 4,620 cords, at a cost of $22,566.30.

During the fiscal year under their contract of February 28, 1887, for construction of breakwater, they built, sunk, filled with stone, and riprapped 23 cribs of an average of 19 courses in height. They built superstructure and parapet on 12 cribs, thereby completing 600 linear feet

of breakwater, and bonded and leveled and partly built superstructure over 4 other cribs. Their work was well and expeditiously done.

They will finish the 200 linear feet of superstructure and complete their contract to extent of available funds by August 15, 1888.

Mr. Charles W. Scofield completed the delivery of iron under his contract of January 3, 1887, in July, 1887.

Repairs to piers and breakwater were made at various times during the year by "hired labor and purchase in open market," the character and small quantity of the work to be done making that system more economical and advantageous than the contract method.

For this work about $650 was expended during the fiscal year.

At the close of the fiscal year ending June 30, 1888, the piers were in fair repair, and the west breakwater in fair condition and withstanding well the action of the storms.

Some slight repairs were needed to piers and breakwater which will be commenced when funds are available.

There was only a 15½-foot channel between the piers and to deep water in the lake.

Dredging was badly needed, but under the special wording of the act of 1886 it was not deemed proper to apply any of the funds to that purpose. The city of Cleveland did some excavation to relieve the channel, but not sufficient to restore full width of channel to full 16 feet depth.

The cost of the proposed east breakwater, 3,500 feet long, was estimated to be about $440,000. The estimated cost of the harbor of refuge as originally projected and approved was $1,800,000. The amount expended up to the present time, the west breakwater being completed as originally designed, is $933,764.25. When the work now recommended is constructed the total cost of the harbor of refuge under the project now approved will be about $1,613,000, which is $187,000 less than the original estimate.

A Board of Engineers in 1884 further recommended, in order that the harbor may completely fulfill the objects for which it was constructed, that a harbor-master be appointed, and that a strong sea-going tug be employed during the season of navigation to tow in and place vessels which can not be handled by the river tugs.

The same Board of Engineers also recommended the construction of a parapet about 4 feet high and 16 feet wide on the present west breakwater, to prevent the pouring over into the harbor of the large volume of water thrown therein during heavy gales, which, it is asserted, raises the level of the water within the harbor to such an extent as to produce a very strong current out of it at the entrance.

The cost of such a parapet would probably be about $60,000.

Proposals for constructing this parapet wall were opened May 10, 1887, and resulted in the execution of a contract with B. S. Horton, of Vermillion, Ohio, for the construction of about 3,500 linear feet for the available sum of $30,000. Work was commenced June 1, 1887, and continued until the close of November, 1887, when the contract was completed. Three thousand five hundred and thirty of the 7,000 feet proposed by the Board of Engineers were finished at an average cost per foot of $8.35.

The original estimate for the harbor of refuge was $1,800,000. About $843,000 has been expended on the west breakwater and five-sixths of the original plan completed. The east breakwater under the proposed change of plan is estimated to cost $740,000, so that the harbor of refuge, with an eastern breakwater, can be completed for about $187,000 less than the original estimate.

The amount estimated as required for the approved change in project is $619,000, which sum should be appropriated in one allotment, and can be profitably expended during the fiscal year ending June 30, 1890.

The harbor of refuge, as now planned, will, when completed, be about 2½ miles long, and offers an area of 500 acres for anchorage, the depth in 200 acres of which will be from 17 to 29 feet.

The total expenditure for the fiscal year ending June 30, 1888, including repairs, contingencies, etc., was $151,824.07. The total amount appropriated to July 1, 1888, for the harbor of refuge is $993,750, all of which sum, including outstanding indebtedness, has been expended; about $36,000 of the amount thus appropriated having been expended in repairs to piers, dredging, etc., for Cleveland Harbor proper.

An abstract of contracts is transmitted herewith:

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on the shore and a beacon on the outer end of each pier, and a beacon on the independent crib just inside the east end of the lake arm of the breakwater. The nearest work of defense is Fort Wayne, Mich., 110 miles distant.

The amount of revenue collected during the fiscal year ending June 30, 1887, was $299,330.60. No report was received for the fiscal year ending June 30, 1888.

The imports, consisting of general merchandise, iron ore, lumber, coal, provisions, etc., amounted in value to $43,884,336. The exports, consisting of general merchandise, coal, iron, and oil, amounted in value to $34,988,095 for the year ending December 31, 1887, there having been no report submitted embracing a later date.

For the same period, the year 1887, twenty-nine hundred and thirty-six vessels, with an aggregate tonnage of 1,468,169 tons, entered and twenty-nine hundred and twenty-eight vessels, with an aggregate tonnage of 1,534,147 tons, cleared.

During the fiscal year ending June 30, 1887, the largest cargo of the vessels entering or clearing was 2,700 tons of coal, and the deepest draught was 16 feet.

Money statement.

July 1, 1887, amount available		$165,922.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	149,687.23	
July 1, 1888, outstanding liabilities	10,518.26	
July 1, 1888, amount covered by existing contracts	5,717.49	
		165,922.98
Amount appropriated by act of August 11, 1888		100,000.00
Amount (estimated) required for completion of existing project		519,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contracts for improving harbor at Cleveland, Ohio, in force during the fiscal year ending June 30, 1888.

1. Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 28, 1886, for furnishing and placing 3,600 cords, more or less, of rubble-stone for foundation for east breakwater.

Rate paid, $4.90 per cord (of 128 cubic feet), delivered and placed. Contract extended as to time of completion to September 1, 1887. Contract completed and closed.

2. Contract with Charles W. Scofield, of Cleveland, Ohio, dated January 13, 1887, for furnishing the iron required in the construction of 1,218 linear feet, more or less, of east breakwater:

Material.	Rate.	Material.	Rate.
Iron plates ... per pound	$0.03½	Boat spikes ... per pound	$0.02[illegible]
Iron angle plates ... do	.03½	Bands with hinge ends ... each	1.19
S. & W. bolts ... do	.03¼	Bands with hinge and angle ends ... do	1.64
Drift-bolts ... do	.02½	Tie-rods ... do	2.88
Button-headed bolts ... do	.03	Turnbuckles ... do	1.18
Strap-irons ... do	.03		

Contract extended as to time of completion to July 15, 1887. Contract completed and closed.

3. Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated February 28, 1887, for furnishing all the materials except iron, and doing all the work required in the construction of 1,218 linear feet, more or less, of east breakwater.

Material.	Rate.	Material.	Rate.
Hemlock ..... per M feet, B. M..	$22.00	Foundation and filling stone, per cord.	$5.50
White pine ..... do....	28 00	Riprap stone, per ton	1.50
White oak ..... do....	30.00	Treenails, per 100.....	5.00

Work in progress. Time for completion of contract extended to September 30, 1888

4. Contract with B. S. Horton, of Vermillion, Ohio, dated May 27, 1887, for the construction of 4,000 linear feet, more or less, of parapet wall on west breakwater.

Material.	Rate.	Material.	Rate.
White pine ..... per M feet, B. M..	$30.50	Spikes ..... per pound..	$0.4
White oak ..... do ...	35.00	S. and W. bolts..... do....	.04½
Filling-stone ..... per cord..	6.00	Removing and replacing decking, per 100 linear feet.....	50.00
Drift-bolts ..... per pound..	.03½		

Contract completed and closed.

PROPOSED EXTENSION OF THE EAST BREAKWATER, CLEVELAND, OHIO.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 25, 1888.

SIR: I have the honor to return herewith the resolution of the House of Representatives of the United States, dated February 20, 1888, requesting the Secretary of War "to transmit to this House, for the use of the Committee on Rivers and Harbors, all papers, maps, tracings, and recommendations now on file in the War Department in relation to the breakwater at Cleveland, Ohio; especially all such papers, maps, tracings, and recommendations as relate to the extension of such breakwater easterly, substantially on the present line without material deflection toward the shore, for the whole length now authorized and an additional length of not less than 2,000 feet," and in reply thereto to submit the inclosed copy of the report of Maj. L. C. Overman, Corps of Engineers, dated February 21, instant, together with papers and maps on file in this office in relation to the proposed extension of the east breakwater at Cleveland, Ohio, for an additional length of 2,000 feet, which, it is believed, will furnish all required information upon the subject.

It will be seen that Major Overman gives succinctly and clearly a description of the proposed extension of the east breakwater at Cleveland, Ohio, together with an estimate of its cost, stated at $300,000.

Should the proposed modification be adopted the area of "anchorage space beyond the 16-foot curve will be increased from about 75 to 200 acres, and the shore-arm is located for its entire length in water averaging 26 feet in depth or over; and the conformation of the shore-line is such that this shore-arm can be further extended 2,200 feet when required, and still leave the inshore extremity in 24 feet depth of water,

with an opening nearly 1,300 feet between it and the curve of 16 feet depth."

The original estimate for the harbor of refuge at Cleveland was $1,800,000.

The west breakwater completed in 1883, including repairs, cost about	$813,000
To which add the estimated cost for the parapet for same	60,000
	873,000
The east breakwater as at present projected is estimated to cost	440,000
Making a total of	1,313,000
Amount appropriated to date	993,750
Estimated amount required to complete on present plan is	319,250
Add to this the amount required for the proposed extension of the east breakwater	300,000
The total amount will be	619,250
Which is less than the original estimate by the sum of	187,000

I concur fully in Major Overman's recommendation that the proposed extension be authorized.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF MAJOR L. COOPER OVERMAN, CORPS OF ENGINEERS.

WASHINGTON, D. C., *February* 21, 1888.

GENERAL: In reply to your letter of February 20, 1888, relating to the proposed "extension of the Cleveland Breakwater," I have to respectfully submit the following:

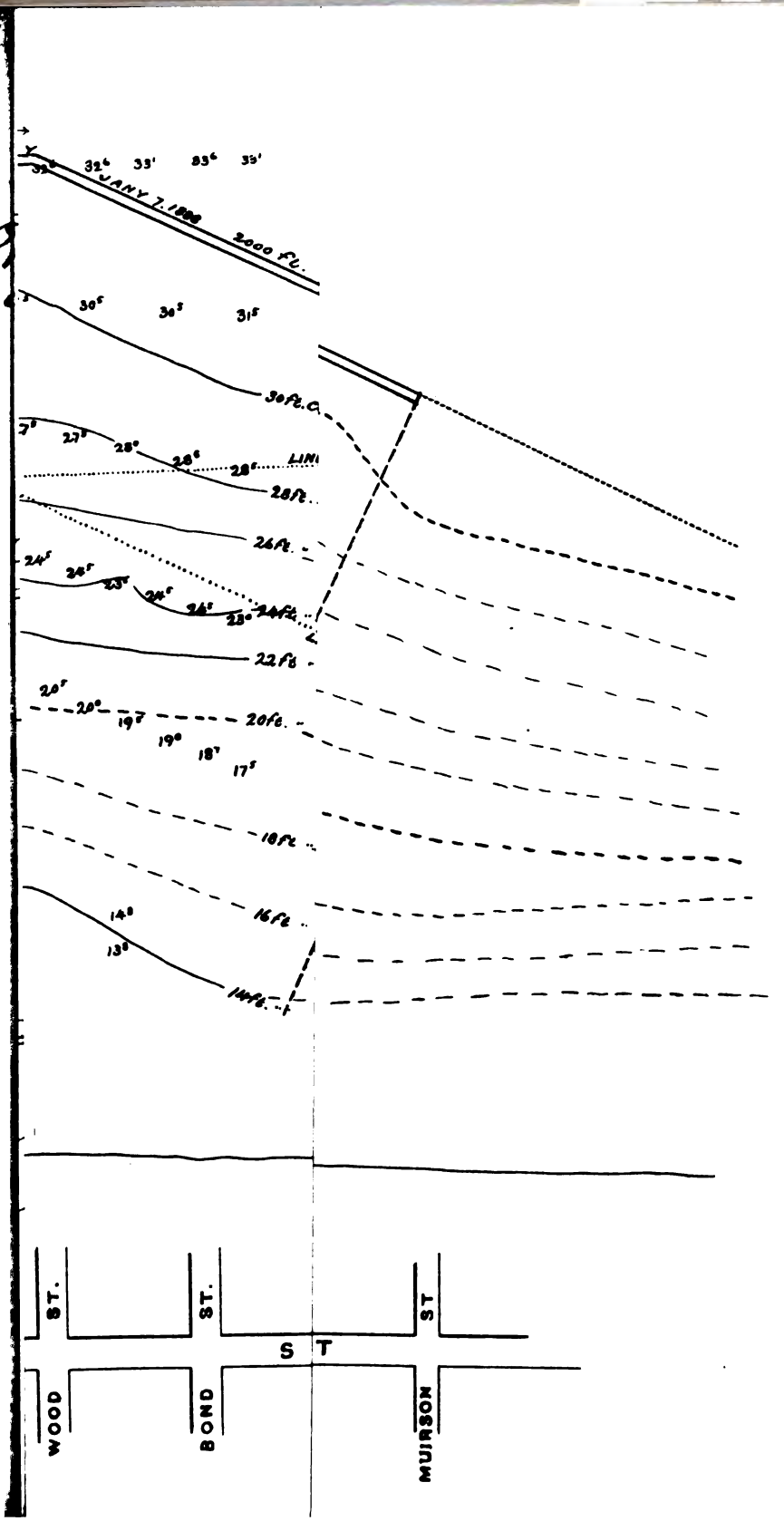
The present project for the completion of the harbor of refuge at Cleveland, Ohio, adopted in 1884, provides for an east breakwater, which begins at a point on the prolongation of the lake arm of the west breakwater, and 500 feet from it; extends eastward on the line about 1,100 feet, then inclines towards the shore in a depth of 25 feet of water, and extends 2,400 feet, having an entrance 1,200 feet wide between the eastern end and the curve of 14 feet depth. (See tracing.)

On account of the rapidly increasing commerce of the lakes, the increased size and increased draught of vessels now employed and now building, and to provide for further enlargement in the future when required, it is proposed to modify the present plan and thereby extend the east breakwater.

The reasons for this change are fully represented in the report of the Cleveland Board of Trade.

Briefly described, it is proposed to extend the lake arm of the east breakwater, as at present projected, from about 1,100 feet in length to 3,500 feet in length, then incline towards the shore on a line parallel with the present projected breakwater, and construct 2,000 linear feet of breakwater, making a total of 5,500 linear feet for the east breakwater. (See tracing.)

By this modification the anchorage space beyond the 16-foot curve is increased from about 75 acres to 200 acres, and the shore-arm is located for its entire length in water averaging 26 feet in depth or over; and the conformation of the shore-line is such that this shore-arm can be further extended 2,200 feet when required, and still leave the inshore extremity in 24 feet depth of water, with an opening nearly 1,300 feet between it and the curve of 16 feet depth.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with an opening nearly 1,300 feet between it and the curve of 16 feet depth."

The original estimate for the harbor of refuge at Cleveland was $1,800,000.

The west breakwater completed in 1883, including repairs, cost about	$813,000
To which add the estimated cost for the parapet for same	60,000
	873,000
The east breakwater as at present projected is estimated to cost	440,000
Making a total of	1,313,000
Amount appropriated to date	993,750
Estimated amount required to complete on present plan is	319,250
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The total amount will be	619,250
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I concur fully in Major Overman's recommendation that the proposed extension be authorized.

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On account of the rapidly increasing commerce of the lakes, the increased size and increased draught of vessels now employed and now building, and to provide for further enlargement in the future when required, it is proposed to modify the present plan and thereby extend the east breakwater.

The reasons for this change are fully represented in the report of the Cleveland Board of Trade.

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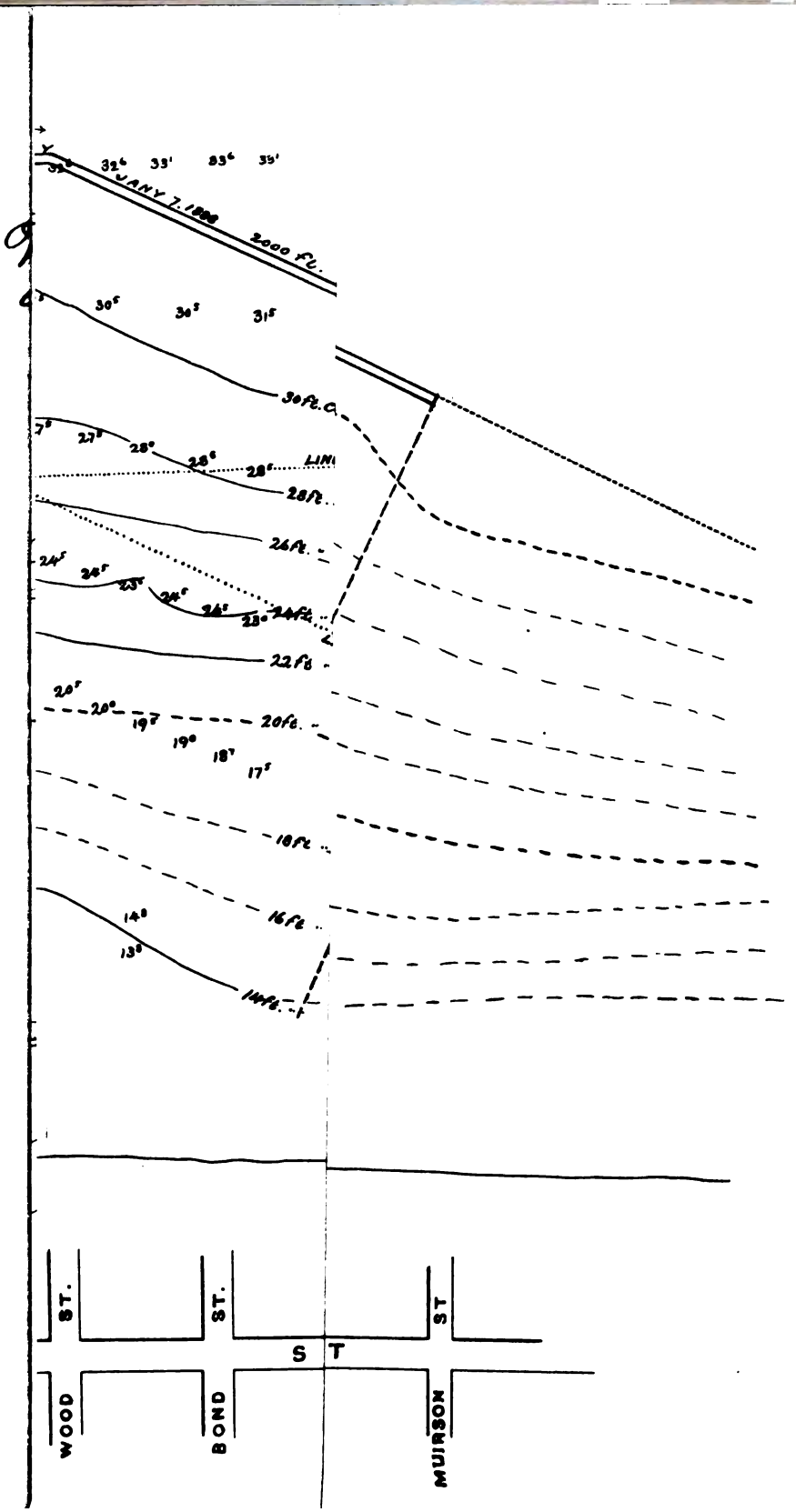
By this modification the anchorage space beyond the 16-foot curve is increased from about 75 acres to 200 acres, and the shore-arm is located for its entire length in water averaging 26 feet in depth or over; and the conformation of the shore-line is such that this shore-arm can be further extended 2,200 feet when required, and still leave the inshore extremity in 24 feet depth of water, with an opening nearly 1,300 feet between it and the curve of 16 feet depth.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The west breakwater, completed in 1883, together with repairs to same, ost in round numbers $813,000; to which add the estimated cost for the arapet for same, $60,000.

The east breakwater as at present projected is estimated to cost 140,000, making a total of $1,313,000.

There has been appropriated to date for the harbor of refuge $993,750, o that the estimated amount required to complete according to present lan is $319,250.

The proposed extension requires the construction of about 2,000 linar feet additional of breakwater, in water of an average depth of 28 eet, and will cost (at present contract prices) about $150 per linear foot, r $300,000 for the extension, making a total of $619,250 to complete n the proposed enlarged plan.

The total cost of the harbor of refuge would then be $1,613,000, or 187,000 less than the original estimate.

If, then, Congress in 1875 deemed it advisable to commence a work estiated to cost $1,800,000 there should be no hesitation in 1888, when he needs of commerce are more than quadrupled, to sanction a change f plan which materially enlarges and improves the harbor of refuge t a cost of $187,000 less than the original estimate.

Weighed against the interests to be benefited and the large amount f commerce to be accommodated, the amount required for the extenion is very small.

I have, therefore, to earnestly recommend that the proposed extension f the east breakwater at Cleveland Harbor, Ohio, be sanctioned and pproved.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

ETTER OF COMMITTEE OF BOARD OF TRADE AND BOARD OF INDUSTRIES OF CLEVELAND, OHIO.

CLEVELAND, OHIO, *February* 6, 1888.

The committee appointed by the Board of Trade and Board of Industries of Clevend, Ohio, respectfully transmit herewith a printed copy of the report of the committe regarding the need for an enlargement of the harbor of refuge at Cleveland, Ohio. They respectfully invite your careful attention to the report, and request the same ay be referred to Congress at as early a day as possible.

Very respectfully, yours,

AMOS TOWNSEND,
GEO. W. GARDNER.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

(Through Major Overman, the officer in immediate charge.)

:PORT OF THE SPECIAL COMMITTEE OF THE BOARD OF INDUSTRY AND IMPROVEMENT OF CLEVELAND, OHIO, RECOMMENDING A CHANGE OF PLAN, SO AS TO EXTEND THE EASTERN BREAKWATER FOR HARBOR OF REFUGE PURPOSES.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, January 17, 1888.

DEAR SIR: I take pleasure in sending herewith tracing showing present plan of st breakwater, with line recommended by Board of Engineers, 1884; line as modified Chief of Engineers, 1884; line that Chief of Engineers may further modify; line

recommended by your committee for extension, 1887. It has been drawn so that it can be photolithographed and copy made for each copy of the printed report.

Hoping that this will be satisfactory,

Very respectfully,

L. COOPER OVERMAN,
Major of Engineers.

GEO. W. GARDNER, Esq.,
Chairman of Committee of Breakwater Extension, City.

REPORT.

Your committee, to whom was referred the matter of extension of the eastern breakwater at Cleveland, beg to report, after full investigation and conference with Major Overman, in charge of the Government works in this district, and with those interested in lake navigation and familiar with improvements of this character, that, owing to the remarkable growth and rapidly increasing magnitude of lake commerce and the increased size of vessels built for that service, there is need for greater protection and anchorage space than would be provided by the breakwater, if completed under the present plan, and that, if the actual condition of things is properly made known before the work has progressed too far on the present plan, there should be little difficulty in procuring such changes as the necessities of the case fairly require.

The breakwater at Cleveland was begun under a plan submitted in 1875 for a harbor of refuge at this place. This plan need not be described, as under it, with some modifications, the present west breakwater was built and completed in 1883. By that time the business of lake navigation had increased to such an extent as to make it apparent that the work would be insufficient, and accordingly in May, 1884, a plan was submitted to Major Overman and adopted to build an eastern arm or breakwater, extending in all about 3,500 feet in a broken line, with two salient angles, convex toward the lake, ending about 2,600 feet from the shore, in a depth of 25 feet of water, and having between its eastern end and the curve of 14 feet depth of water an entrance 1,200 feet wide.

According to the computations of the United States engineer, this eastern breakwater would give an increased area of protected space between it and the 14-foot curve of about 120 acres during northwest gales, and about 70 acres during northeast gales. This, it was supposed at the time, would afford ample protection, according to the necessities of commerce existing at that time, and considering also the prospective growth of the trade.

The necessity for enlargement was made apparent by the condition of the lake marine, as shown by the statistics of 1883; and your committee have accordingly procured the statistics, for the purpose of comparison, of the years 1875, when the breakwater was commenced; of 1883, by which time the enlargement seemed to be necessary, and of the past season of 1887, and also of the ship-building now in progress, although as to the latter full statistics could not be obtained.

Since 1884 the growth of lake commerce has been much greater than could have been anticipated at that time. It is at present developing rapidly, and will continue to increase in volume. Much of this growth is due to the wonderful development of the Northwest. The estimated increase of shipments of ore from the iron mines of the Northwest is 2,000,000 of tons over the similar shipments of 1887, being an estimated increase of nearly 50 per cent. The mention of this single instance will convey an idea of the probable future magnitude of the lake commerce, and nearly all of this ore comes to Lake Erie ports. For the season of 1875, when the original plan of the breakwater was adopted, the business of this district alone was: Clearances and entrances, coastwise, number of vessels, 4,799; tonnage, 1,883,760. The business of the district increased so much that in the season of 1883 the number of vessels entering and clearing was 7,509; tonnage, 3,227,520 tons. The increase, therefore, during the eight years from 1875 to 1883, inclusive, was in number of vessels entering and clearing, 2,710, and in tonnage, 1,343,760 tons.

It will be noticed that no account is given here of the number of vessels which, having cleared from some district for another district beyond Cleveland, call here in the course of their business without being required to either enter or clear at this port. No statistics showing the number is at hand to be given here, but it is common knowledge that the number of such vessels is very large.

Such a growth of the local business, and an increase in through business past this district using the harbor of refuge as the occasion required, which probably corresponded very nearly with the growth of local business, was sufficient to make necessary so great an enlargement of our harbor of refuge as the building of the east breakwater contemplated. Since the adoption of this plan in 1884 the growth of the busi-

ness in this district has been much more rapid and extensive, as will be seen by the following statement of the business of the season of 1887, when the coastwise entrances and clearances numbered 8,434; tonnage, 5,061,165 tons, an increase in four years in number of 925, and in tonnage 1,833,645 tons. These statistics show that the increase in a season's business in this district alone during the past four years, since the adoption of the plan for building the east breakwater, exceeds by 500,000 tons the similar increase during the eight years from 1875 to 1883; and that such increase alone of the past four years is only 50,000 tons less than the total tonnage of this district for the year 1875, when the building of the breakwater was commenced.

Such an increase in the tonnage indicates *the larger size* of the vessels now engaged in our lake business, as compared with either 1875 or 1883. This is further illustrated by an examination of the statistics of ship-building. During the six years from 1870 to 1875, inclusive, there were built on the lakes 41 steam-ships over 200 feet in length. Of these the largest was 265 feet in length, the next largest 238 feet, while the average length of the 41 vessels was 218 feet, and the average tonnage about 1,050 tons each. Since the adoption of Major Overman's plan for an eastern breakwater, in 1884, and including that year, there have been built in four years, and are now in process of construction on the lakes, 85 steamers alone of over 1,000 tons. Two of these steam-ships, building in Buffalo, and which will be ready for service next spring, are 350 feet each in length, with carrying capacity of 2,800 tons, on a draught of 35 feet 6 inches. Nine steel steamers, now building in Cleveland, are each 310 feet in length, with 24½ feet depth of hold; tonnage, 2,800 tons. Three others have been recently completed here, respectively 277 feet in length, 23 feet depth, 2,566 tonnage; 280 feet in length, 23 feet depth, 2,600 tonnage, and 302 feet in length, 24 feet depth, 2,650 tonnage. There are also building here one steel steamer, 290 feet in length, and one of over 300 feet in length. And, in addition to the above steel steamers, there have been built the past season and are now building at Cleveland eighteen wooden steamers, varying in length from 246 to 310 feet, with an average length of 270 feet, and average carrying capacity of 2,250 tons. There have been built this year and are now building in Detroit fourteen vessels over 1,000 tons, nine of which are over 250 feet in length each, and one of which is 275 feet long, and two 286 feet long. These vessels are from 22 to 26 feet depth of hold, and their tonnage is from 1,800 to 2,650 tons. Six vessels have been built the past season in Bay City of an average length of 280 feet; and there are now under construction at the same place ten vessels which will average 1,800 tons each. There are other ship-building ports on the lakes from which your committee were unable to get full statistics, where considerable ship-building has been done, and is now being done, notably Milwaukee, where there are several vessels of the largest size now in process of construction. These vessels referred to are steamers, built at a cost of from $125,000 to $200,000 each, and a few are built at a cost reaching $350,000 each. A large number of sail-vessels, including lake barges of corresponding size, have been built recently and are now building.

Comparatively little is known by the general public of the great magnitude of the lake commerce. It has assumed grand proportions, and the vessels we are now putting afloat exceed those built in this country for ordinary traffic on the ocean. The statistics show that, without including the recent additions to the lake fleet above referred to, the total number of vessels navigating the lakes at the close of the season of navigation of 1886 was 3,405, being more than the entire number of vessels enrolled in the United States custom-houses for navigation of the Pacific coast and the inland rivers, and nearly one-sixth of the whole number of vessels enrolled in all the custom-houses of the United States. And the tonnage of this lake fleet, as shown by the official report of June 7, 1887, is more than double in extent the total tonnage engaged in river and inland navigation in the United States; exceeds the combined tonnage of the river and inland navigation and the Pacific coast; is nearly one-third as great as the entire tonnage of the Atlantic and Gulf coasts; and is more than one-sixth of all the tonnage registered or enrolled in the United States.

A vast number of men is required to man this immense fleet on the lakes, such vessels as above described each requiring a crew of from fifteen to twenty men, and it is conceded that no coast is more dangerous, and that no navigation is more hazardous than that of our northwestern lakes. The propriety and necessity of affording the best protection on a dangerous coast of this valuable fleet and the men who navigate it, and who at best accept great risks in their calling, requires no argument; but statistics for the year 1887 show that while fortunately there was no large number lost in any one disaster, yet 204 lives were lost in the navigation of the lakes last season, while the total losses of steam and sail vessels amounted to $1,257,250, and the partial losses amounted to $701,500, without taking into account the numerous minor mishaps. Not only does our local business rely upon the protection afforded by our breakwater, but the through business on Lake Erie depends upon this harbor of refuge, and to the entire lake commerce its value depends upon the adequacy of the protection afforded by it, and its accessibility in storms. Statistics have been given showing the recent enormous increase of the lake business in this district only.

Lack of space forbids our going into a similar showing of the increase at other ports, such as Chicago, Milwaukee, Duluth, Detroit, Toledo, and Buffalo, where there has been a proportionate growth of business. Suffice it to say, that the through business past Detroit, up and down, last year, the bulk of which either came into or passed the Cleveland district, reached the number of about 20,000 vessel passages, and this in a season which began later than usual, to wit, about the 1st of May.

It will be noticed that in dealing with the distance of the breakwater from the shore *the curve at* 14 *feet depth of water* has uniformly been mentioned. Such a depth of water might be considered a factor in safe navigation in 1875, but the increase in the depth of our lake vessels, and the draught of water to which they can safely be loaded, has kept pace with the increase in length and tonnage. There is need of greater depth of water than 14 feet in every channel of the lakes, and it is believed that in all recommendations made and plans adopted for the improvement of channels during the past five years a greater depth than 14 feet has been assumed as necessary. All the vessels mentioned as having been built in the past four years, and now building, can safely load to a draught of from 16 to 18 feet, if assured sufficient water, and efforts are being made throughout the lakes to increase the depth of channels and harbors accordingly. It is to be considered also that it is in storms, when heavy seas are prevailing, that the harbor of refuge is used, so that a vessel would need for safety in entering the harbor a very considerably greater depth of water than she might herself be drawing, owing to the rise and fall of the vessel in the seaway. Your committee are unable to say what width of entrance there would be between the curve of 18 feet depth of water and the east end of the breakwater, if completed under the present plan, but it would necessarily be much less than the 1,200 feet considered advisable in 1883, and which is the width to the curve of 14 feet depth of water. We call attention in this connection to the fact that the east end of the breakwater would itself be in but 25 feet of water.

An examination of the plans and surveys, kindly afforded by Major Overman, shows that if the east arm of the breakwater could be prolonged in a straight line easterly before the line is broken by a deflection southerly, the east end would be in deeper water, and a channel available for vessels drawing 16 feet of water or more could thus be afforded, of sufficient width between the east end and the shore, affording another entrance at the easterly and equally as safe as the main entrance to the harbor of refuge. Nothing limits the extension of the breakwater easterly but the plan adopted in 1884, which can not be materially altered, as your committee are informed, without further legislation by Congress. It was supposed when the plan of 1884 was adopted that the enlargement of the harbor of refuge provided for in that plan was adequate for the then necessities of commerce, and would be adequate for years to come. The development of lake commerce during the last four years, exceeding the whole increase from the time the first breakwater was authorized until an enlargement was seen to be necessary in 1884, proves that the future growth of the business was not understood or properly estimated, even by those most interested in its success. *If completed on the present plan, it would thereafter be practically impossible to enlarge the breakwater* so as to afford the needed protection, but the work on the eastern breakwater has not yet so far progressed as to interfere in any manner with the proposition to extend it east and provide adequate protection.

Your committee therefore report:

(1) That there is imperative necessity for enlarging the breakwater beyond the present plan, and that, if completed on the present plan, the protected space in the harbor of refuge will be entirely inadequate to the needs of commerce.

(2) That it is not, as your committee is informed, within the authority of the War Department without Congressional action to vary materially from the present authorized plan for the breakwater.

(3) That it is necessary, owing to the fact that the work is now in progress, that any steps taken for the alteration of the present plan be taken promptly.

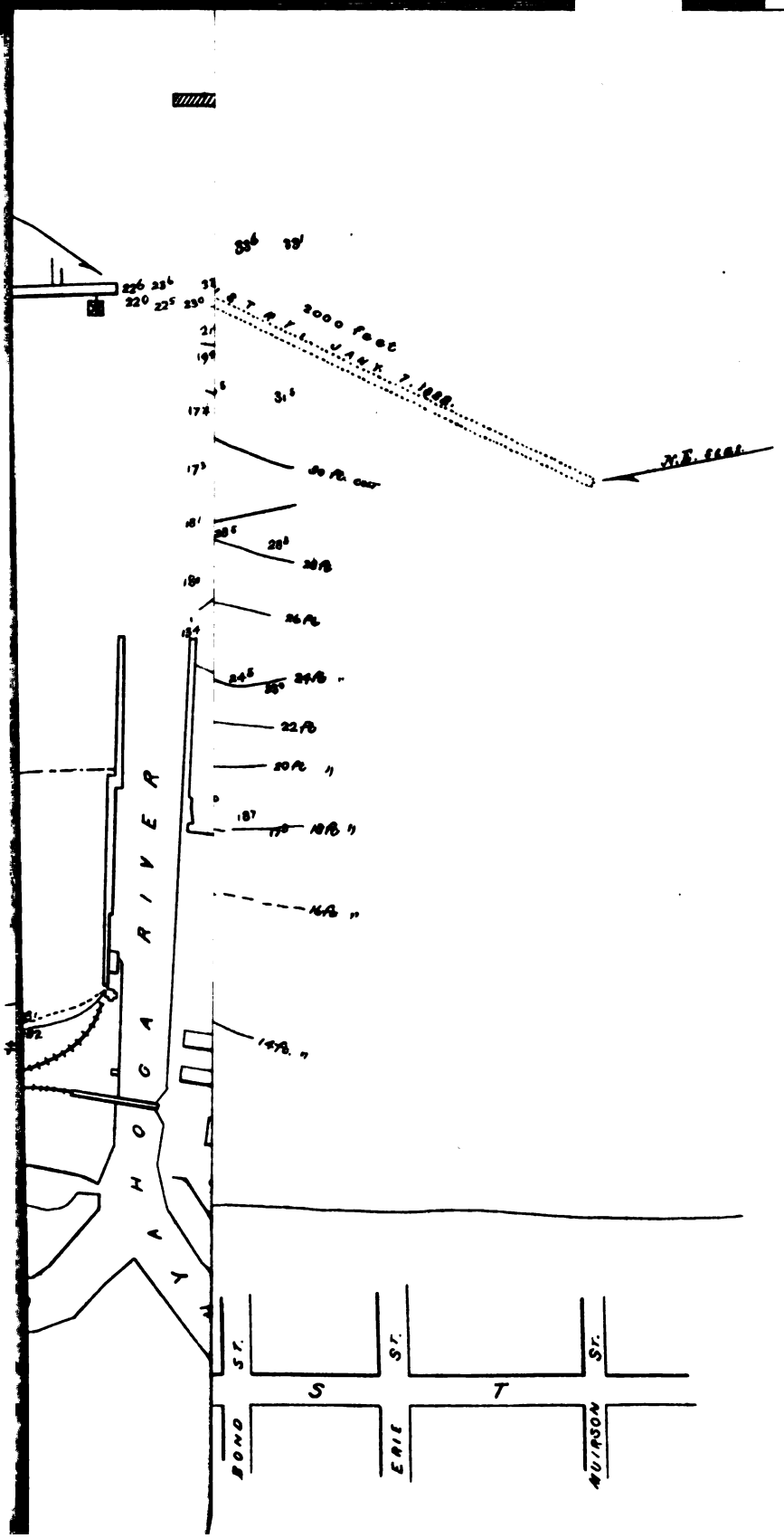
And in view of the facts set out in the foregoing report, your committee recommend:

(1) That the breakwater be extended easterly, substantially on the present line, without material deflection toward the shore, for the whole length now authorized, and an additional length of not less than 2,000 feet, so that the entire length of the eastern arm, from the beginning, will be at least 5,500 feet. If so extended, the necessity for building a shore arm at the easterly end may be obviated, and a large annual expense for dredging avoided, which would probably accrue if built as the present plan provides.

(2) That the Government provide for the appointment of a Government harbormaster, and a strong sea-going tug, to be employed during the season of navigation to tow in and place vessels which can not be handled by the harbor tugs.

(3) That this board use its influence to the end that the above recommendations, if adopted, be carried out.

(4) That this board request Senators Sherman and Payne and Congressman Foran,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An examination of the plans and surveys, kindly afforded by Major Overman, shows that if the east arm of the breakwater could be prolonged in a straight line easterly before the line is broken by a deflection southerly, the east end would be in deeper water, and a channel available for vessels drawing 16 feet of water or more could thus be afforded, of sufficient width between the east end and the shore, affording another entrance at the easterly and equally as safe as the main entrance to the harbor of refuge. Nothing limits the extension of the breakwater easterly but the plan adopted in 1884, which can not be materially altered, as your committee are informed, without further legislation by Congress. It was supposed when the plan of 1884 was adopted that the enlargement of the harbor of refuge provided for in that plan was adequate for the then necessities of commerce, and would be adequate for years to come. The development of lake commerce during the last four years, exceeding the whole increase from the time the first breakwater was authorized until an enlargement was seen to be necessary in 1884, proves that the future growth of the business was not understood or properly estimated, even by those most interested in its success. *If completed on the present plan, it would thereafter be practically impossib to enlarge the breakwater* so as to afford the needed protection, but the work on th eastern breakwater has not yet so far progressed as to interfere in any manner wi the proposition to extend it east and provide adequate protection.

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(2) That it is not, as your committee is informed, within the authority of the Department without Congressional action to vary materially from the presen thorized plan for the breakwater.

(3) That it is necessary, owing to the fact that the work is now in progress any steps taken for the alteration of the present plan be taken promptly.

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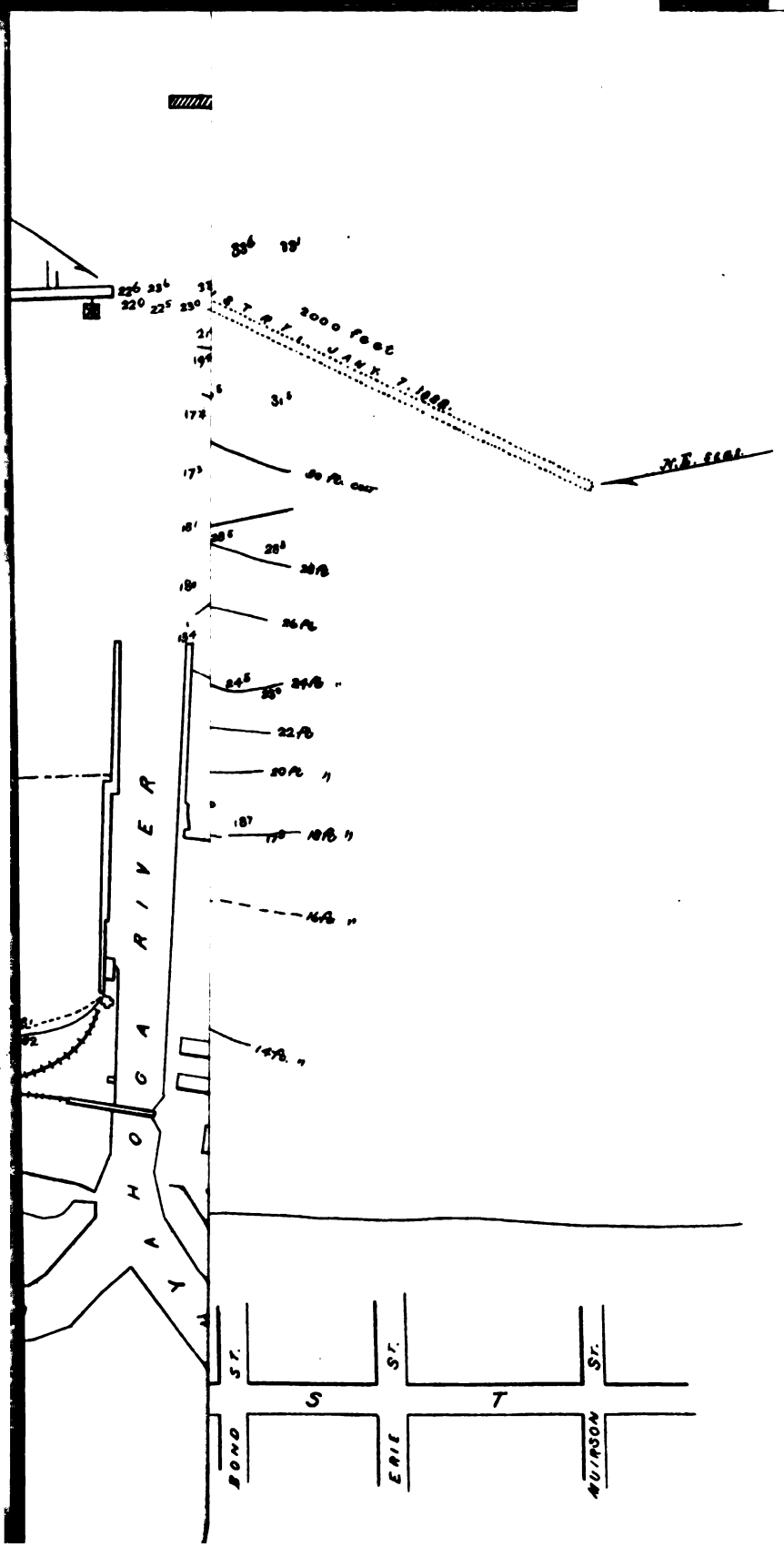
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ERIE ST.
MUIRSON ST.
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Senators and Representatives of other lake districts who are equally interested, onsider the necessity for this improvement, and to aid in securing the necessary lation therefor.

id your committee submit the accompanying resolutions on this subject, passed ne Lake Carriers' Association, of Buffalo, an association embodying in its mem-hip representatives from all the lake cities, and whose object is "to consider and action upon all general questions relating to the navigation and carrying business ie Great Lakes;" and also resolutions passed by the Cleveland Vessel Owners' ciation.

GEORGE W. GARDNER.
AMOS TOWNSEND.
HARVEY D. GOULDER.
B. D. BABCOCK.
THOMAS AXWORTHY.

a meeting of the Cleveland Board of Industry and Improvement, held this day, above report was unanimously adopted, and it was ordered that 500 copies of the be printed, with the necessary maps and explanations.

WILSON M. DAY,
Secretary pro tem.

EVELAND, OHIO, *January* 7, 1888.

RESOLUTIONS OF THE LAKE CARRIERS' ASSOCIATION.

BUFFALO, *December* 22, 1887.

a meeting of the board of managers of the Lake Carriers' Association, held at alo this date, the following resolutions were adopted:

hereas certain improvements and additions to the Government breakwater at eland are now being made by the United States; and

hereas the recent large increase in the size of the vessels building on the Great es has rendered inadequate the construction of the breakwater on the present ; and

hereas the Cleveland Board of Industry and Cleveland Board of Trade have sug-ed a change such as to provide a greater area of protected harbor space for refuge oses, with draught of water sufficient for the largest vessels:

solved, That the board of managers of the Lake Carriers' Association consider it important for the marine interests of the Great Lakes that the refuge facilities leveland should be ample; also,

solved, That certified copies of this resolution be sent to the Secretary of War, to United States engineer in charge of the work, and to other persons interested.

FRANCIS ALMY,
Secretary.

aj. L. C. OVERMAN,
U. S. Engineer.

K K 11.

IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

rand River rises in the northeastern part of Ohio, and after a very uitous course empties into Lake Erie at a point about midway be-en its eastern and western extremities.

. full description of the operations carried on for the improvement his harbor during past years will be found in annual reports of 1880 1881.

he project of improvement adopted in 1825, when the mouth of the r was closed by a sand-bar, so hard and dry in summer that teams ld drive across, and which project has been amended from time to since that date as the demands of commerce called for an increased th of water, provides for parallel piers, 200 feet apart, running out each side of the entrance to a depth of 16 feet in the lake.

OPERATIONS DURING THE FISCAL YEAR.

At the close of this fiscal year there was only a 15-foot channel between piers and a 14½-foot channel through the bars in lake at entrance to harbor. Dredging is badly needed, and the increased commerce of the harbor demands early relief.

On March 8, 1887, proposals were invited for furnishing the materials and doing the work necessary for the extension of the east pier 200 linear feet. A contract was executed March 16, 1887, with Keer, Stang & Gillmore, of Lorain, Ohio.

By September, 1887, the whole work was completed, and the east pier thereby extended 200 feet, which makes the two piers extend to similar depth in the lake, and it is hoped will check the recurrence of the bar at entrance to piers.

Some trouble was occasioned by a small bar forming this spring in lake beyond end of piers, and dredging to the extent of available funds (about $500) was done to remedy it.

During the fiscal year the sum of $15,212.31 was expended. Up to the close of the fiscal year the sum of $256,531.68 has been appropriated for this harbor, all of which has been expended.

The present project provides for an extension of both piers, for repairs, and for dredging, so as to obtain and maintain a good channel 16 feet deep and 200 feet wide from the lake to the railroad docks near mouth of river. The estimated cost is $93,000, of which sum $61,750 has been appropriated, and the balance, $31,250, can be expended during the fiscal year ending June 30, 1890.

Extensive improvements are being made at Fairport Harbor by Pittsburgh capitalists. These changes and improvements, it is expected, will be continued during the summer of 1888, and, as expected, they have increased and will still further increase the amount of business of this harbor.

The extension of piers to the extent provided by the project should be accomplished as soon as possible to check the recurrence of the bar formation, and some additional inside dredging will be necessitated by the extension of the docks.

An abstract of contract is transmitted herewith.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on shore and a beacon on the east pier.

The amount of revenue collected during the eleven months ending May 31, 1888, was $434.

The imports, consisting of iron ore and lumber, amounted in value to $3,560,000, and the exports, consisting of coal, coke, etc., amounted in value to $158,000 during the eleven months ending May 31, 1888.

Three hundred and seventy-five vessels, with an aggregate tonnage of 410,000 tons, entered, and three hundred and twenty-four vessels, with an aggregate tonnage of 379,000 tons, cleared during the eleven months ending May 31, 1888.

The largest cargo of vessels entering or clearing was 2,407 tons, and the deepest draught 16¼ feet.

Money statement.

July 1, 1887, amount available	$15,040.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	15,040.41
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	21,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	21,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving harbor at Fairport, Ohio, in force during the fiscal year ending June 30, 1888.

[Contract with Kerr, Stang & Gillmore, of Lorain, Ohio, dated March 16, 1887, for extension of east pier and repairs.]

Material.	Rate.	Material.	Rate.
Hemlock ..... per M feet B. M..	$22.00	Drift-bolts..... per pound..	$0.02½
White pine ..... do....	31.00	Spike..... do....	.04
White oak..... do....	30.00	S. and W. bolts..... do....	.04
Filling stone ..... per cord..	5.60	Treenails ..... per 100 pounds..	5.00
Riprap ..... do....	5.60	Dredging ..... per cubic yard..	.65

Contract time for completion extended to September 30, 1887.
Contract completed and closed.

K K 12.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

The original project for the improvement of this harbor was adopted in 1826, at which time there was a depth of only 2 feet of water on the bar. This project has been modified from time to time in order to meet the demands of commerce and increased draught of vessels navigating the lake. It provided for piers running out into the lake to 12 feet depth of water, whereas the present design is to carry them out to 16 feet depth, and to excavate channel through bar and between piers to secure 17 feet in depth.

Before operations were commenced rock was encountered at 7 to 9 feet below water-surface, extending across the channel in the form of a wide reef, which required blasting and dredging for its removal in order to secure the present depth of 15½ to 16 feet. The present project was continued during the fiscal year under appropriation of August 5, 1886, and the majority of funds expended in rock excavation from channel.

OPERATIONS DURING THE FISCAL YEAR.

The act approved August 5, 1886, appropriated for this harbor the sum of $30,000. A project was submitted for its expenditure, which was approved; it provided for repairs and excavation.

In December, 1886, proposals were invited for the rock excavation to the extent of available funds. A contract was executed with Messrs. Carkin, Stickney & Cram, of East Saginaw, Mich., dated January 20, 1887, for doing the required excavation at the rate of $2 per cubic yard for rock, and 90 cents per cubic yard for sand, gravel, etc. This work was not commenced until June, 1887, as the contractors determined to dredge the shale rock in place as well as the loose material. A powerful dredge was built expressly for the work, and with it operations were begun June 6, 1887, and continued until funds were exhausted. Good success was experienced in dredging the shale rock.

The contractors applied for and obtained an extension of time in which to do the work, and as expected they removed all the material that the available funds ($21,000) would pay for by the end of September, 1887.

About 12,731 cubic yards (scow measurement) of ledge-rock, shale, loose rock, stones, gravel, etc., were dredged and removed under the contract.

A good 17½-foot channel was made through rock-bar in lake, beyond end of piers, 160 feet in width and about 350 feet in length. A good 16½-foot channel was made, 50 feet in width, between the piers in the rock bottom and for full length of piers.

The payments made under the contract with Carkin, Stickney & Cram exhausted the appropriation of August 5, 1886, and left no means of doing some necessary dredging called for in spring of 1888.

Under the revised estimate the sum of $50,250 is required to complete the existing project, all of which amount can be profitably expended during the fiscal year ending June 30, 1890.

The piers should be extended as soon as possible, to check the recurrence of the bar forming at end of pier.

The rock excavation should also be completed as early as possible, to make the full-width channel available.

Dredging for the temporary relief of this harbor is almost annually needed, as the harbor is much frequented by the largest class of vessels. After these improvements have been accomplished the removal of the piers can be attended to.

The total amount appropriated for this harbor to the close of the fiscal year ending June 30, 1888, is $402,401.21, all of which has been expended.

An abstract of contract is transmitted herewith.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, varied by flashes, on the west pier. Fort Porter, N. Y., 120 miles distant, is the nearest work of defense.

For the eleven months ending May 31, 1888, the amount of revenue collected was $277.80.

The imports, consisting of iron ore, lumber, and limestone, amounted in value to $5,272,560; the exports, consisting of coal and coke, amounted in value to $1,526,870; for the eleven months ending May 30, 1888.

Nine hundred and five vessels, with an aggregate tonnage of 746,625 tons, entered, and 951 vessels, with an aggregate tonnage of 783,750 tons, cleared, during the eleven months ending May 31, 1888.

Of vessels entering or clearing, the largest cargo was 2,460 tons of iron ore, and the deepest draught was 16 2/12 feet.

Money statement.

July 1, 1887, amount available	$19,057.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,057.58
Amount appropriated by act of August 11, 1888	25,000.00
Amount (estimated) required for completion of existing project	25,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving harbor at Ashtabula, Ohio, in force during the fiscal year ending June 30, 1888.

Contract with Carkin, Stickney & Cram, of East Saginaw, Mich., dated January 20, 1887, for rock excavation and dredging.

Rate paid: For solid rock excavation, $2 per cubic yard, place measurement; for loose rock, stones and gravel, $2 per cubic yard, scow measurement; for sand and mud, 90 cents per cubic yard, scow measurement.

Contract time for completion extended to September 30, 1887.

Contract completed and closed, and final payment made March 24, 1888.

K K 13.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

The project of the improvement of this harbor was adopted in 1829, and the bar at the mouth of Conneaut Creek was dry at low stages of water when the original improvements were commenced.

Operations were carried on during the years 1829 to 1832, and from 1836 to 1838, inclusive, which comprised the construction of piers 125 feet apart running out from shore to a depth of 12 feet of water in the lake, and dredging. The design was to afford a depth of 12 feet of water through the bar and into Conneaut Creek, the harbor of Conneaut.

Works of improvement have progressed with more or less interruptions and suspensions, no work having been done from 1832 to 1836, from 1839 to 1844, from 1845 to 1852, and from 1852 to 1866. No work has been done during the last six fiscal years ending June 30, 1888, and none is contemplated this season, as there are no funds available.

It was recommended in 1880 that improvements should be made at this harbor as follows:

Renewing 800 feet of old east pier, at $30 per foot	$24,000
Rebuilding 790 feet of superstructure, west pier, at $10 per foot	7,900
Contingencies, 10 per cent	3,190
Total	35,090

But as no appropriations for carrying out these repairs and renewals have been made, the piers, etc., have been almost entirely destroyed, and it will require an expenditure of at least $50,000 to restore this harbor to the condition proposed in 1880, when the foregoing estimate was made; and a still larger sum will be needed to put this harbor in condition to meet the present requirements of the lake vessels if the harbor is used by such.

Unless the facilities for transportation by land to and from this harbor should be materially augmented, any outlay for the improvement of the harbor is injudicious. Considerable sums have heretofore been expended in preserving the harbor and its improvements, without drawing private or incorporate enterprise in its direction; therefore, the harbor has heretofore been regarded by citizens and corporations as of questionable advantage as a commercial outlet to and from the lake.

Preparations are in progress by the Shenango and Allegheny Railroad Company for extending their line of road to Conneant for a lake terminus. With a line of railroad from the coal regions of Pennsylvania, this harbor will doubtless be much frequented by lake vessels of the larger class and render extensive improvements necessary. The width between piers will have to be increased, thereby requiring the removal of what now remains of the old east pier and the construction of a new pier about 50 feet to the eastward. The west pier will need extensive repair and renewal, and considerable dredging will be required; all of which it is approximately estimated will cost about $90,000.

The total amount appropriated for this harbor up to the close of the present fiscal year was $112,629.39, all of which has been expended.

The estimated cost in 1880 for completing the existing project was $35,090, which is now increased to $50,000, on account of the deterioration in eight years, and further increased to $90,000 if the harbor is reconstructed to meet the present requirements of the lake vessels;

which latter amount could be expended during the fiscal year ending June 30, 1890, in accordance with the estimate as amended.

As the last river and harbor bill, approved August 5, 1886, made no appropriation of funds for this harbor, no work was practicable, and the piers and revetment have further deteriorated. The piers are in very bad condition, breaches having been made in both, so that the stream now finds an outlet through the east pier, causing a bar, dry at low water, near entrance at end of piers.

Unless some considerable expenditure is soon made for the repair of the piers they will be entirely wrecked and the harbor destroyed.

Conneaut is in the collection district of Cuyahoga, Ohio. There was a fixed white light of the sixth order at the end of the west pier; this light has been moved up on to the bank on account of the dilapidated condition of the pier. Fort Porter, N. Y., 105 miles distant, is the nearest work of defense.

The amount of revenue collected during the eleven months ending May 31, 1885, was $15.95.

During the eleven months ending May 31, 1885, the value of the imports was $80, and of the exports $125. Ten vessels, with an aggregate tonnage of 36 tons, entered, and twelve vessels, with an aggregate tonnage of 395 tons, cleared during the eleven months ending May 31, 1885.

The deepest draught of vessels entering or clearing was 6½ feet.

There have been no commercial reports for the fiscal years 1886, 1887, and 1888. The ex-deputy collector reports that the collector's office was abolished August 10, 1885.

Money statement.

Amount (estimated) required for completion of existing project	$35,090
Amount that can be profitably expended in fiscal year ending June 30, 1890	35,090
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

APPENDIX L L.

IMPROVEMENT OF THE HARBORS OF ERIE, PENNSYLVANIA, AND DUNKIRK, BUFFALO, WILSON, OLCOTT, AND OAK ORCHARD, NEW YORK, AND OF NIAGARA RIVER, NEW YORK.

REPORT OF CAPTAIN FREDERICK A. MAHAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Dunkirk Harbor, New York.
3. Buffalo Harbor, New York.
4. Niagara River, New York.
5. Wilson Harbor, New York.
6. Olcott Harbor, New York.
7. Oak Orchard Harbor, New York.

EXAMINATON AND SURVEY.

8. Tonawanda Harbor and Niagara River, New York, between Black Rock and Tonawanda, with a view to a 16-foot channel.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 1, 1888.

SIR: I have the honor to forward herewith my annual reports of works of river and harbor improvements in my charge during the year ending June 30, 1888.

Very respectfully, your obedient servant,

F. A. MAHAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L L 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

Object.—The object of this improvement is twofold:

1. To protect the harbor from the severe winds that sometimes come from the east and northeast.

2. To obtain and maintain a channel between the harbor and the open lake 16 feet deep and of navigable width.

Project.—The project as originally prepared in 1823 and approved in 1824 provided for closing all the eastern end of the harbor by means of a breakwater on which should be left an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on either side of this opening.

This project is substantially in force at the present time, except that the piers are 350 feet apart.

Present works.—The present works consist of (1) a breakwater, lyin north and south, from the main shore to the south side of the entran to the harbor; (2) of a pier on the south side of the entrance chann nearly east and west in position; (3) of a pier on the north side of th channel, parallel with and 350 feet distant from the one before me tioned; (4) of a breakwater running north from the north pier to th shore of the peninsula. These works are known as the south breal water, the south pier, the north pier, and the north breakwater.

The extensions and lengths of the piers and breakwaters at varion times are given in the following table:

Extension and lengths of the breakwaters and piers.

	South breakwater.		South pier.		North pier.		North breakwater.		Channel.		Remarks.
	Extended.	Total length.	Extended.	Total length.	Extended.	Total length.	Extended.	Total length.	Width.	Depth.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1819	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	
1824	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
1825	.....	.....	.....	.....	900	900	.....	.....	.....	.....	
1826	420	.....	.....	.....	390	1,290	.....	.....	.....	5	Depth increased from 2 to 5.
1827	.....	.....	810	.....	.....	.....	.....	.....	.....	.....	
1828	390	.....	.....	.....	.....	.....	.....	.....	.....	7	
1829	.....	.....	.....	.....	.....	.....	.....	.....	200	7½	First project completed. Original depth given as 1½.
1830	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	
1833	.....	.....	.....	.....	.....	.....	1,234	.....	.....	12	
1844	.....	2,530	.....	780	.....	1,240	.....	2,900	.....	.....	18 feet deep between piers bars at either end.
1867	.....	.....	.....	.....	498	1,738	.....	.....	200	14	37,222 cubic yards sand r moved in outer bar.
1868	.....	.....	.....	.....	.....	.....	.....	.....	100	13	27,000 cubic yards sand r moved from inner bar.
1869	.....	.....	.....	.....	.....	.....	.....	.....	200	14	41,331 cubic yards sand r moved from inner bar.
1870	.....	.....	.....	.....	.....	.....	.....	.....	200	14	27,606 cubic yards sand r moved from inner bar, an 15,466 cubic yards from out bar.
1871	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,777 cubic yards sand fro outer, 40,617 cubic yards san from inner bar.
1872	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,522 cubic yards sand from i ner bar.
1874	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,000 cubic yards sand fro inner bar.
1875	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53,000 cubic yards from bot bars.
1876	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	20,000 cubic yards from out bar.
1877	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,200 cubic yards sand fro outer bar.
1878	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,148 cubic yards sand fro outer bar.
1879	.....	.....	.....	.....	.....	.....	.....	.....	200	15	27,837 cubic yards sand fro outer bar.
1880	.....	.....	.....	.....	.....	.....	.....	.....	350	16	102,763 cubic yards sand re moved from outer bar; 1 snags removed.
1881	.....	.....	.....	.....	160	1,898	.....	.....	350	16	
1882	.....	.....	423	1,203	242	2,140	.....	.....	300	16	25,500 cubic yards clay and sand.
									350		
1883	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,000 cubic yards sand.
1884	.....	.....	.....	.....	.....	.....	.....	.....	300	17	
1887	.....	.....	.....	.....	.....	.....	.....	.....	300	16	36,886 cubic yards sand fro both bars.
1888	.....	.....	.....	1,220	.....	1,970	.....	.....	.....	.....	

NOTE.—In the columns of width and depth of channel, where the figures are not underlined the refer to the entire channel from deep water in the lake to deep water in the bay. Where once under lined they refer to the channel through the outer bar only. Where twice underlined they refer to th channel through the inner bar only.

It will be remarked that the length of the north pier in 1888 is 170 feet less than given in 1882. This is probably owing to the fact that the reported extensions may have been in some cases renewals of work carried away or overturned by storms. Several such accidents are reported.

DAMAGES AND REPAIRS.

South breakwater.—Much damaged by winter gales in 1827. Length of 600 feet raised 4 feet, 1828. Length of 180 feet rebuilt at junction with shore, 1837. Gale in November, 1837, makes a breach around shore end; closed 1838 by extending breakwater 300 feet. Length of 150 feet repaired, 1839. Repaired, except breach 280 feet long near shore, 1845. Repaired, 1846. Thoroughly repaired, 1870. Repaired, 1882. Four breaches, in all 350 linear feet, made during winter of 1886–'87 and rebuilt, 1888. Thorough repairs, 1882.

South pier.—Settled, 1827–'28; raised and refilled, 1829. Breached at junction with south breakwater, 1830. Breach closed, 1834–'35. Repaired and deck plank replaced with flagging. Minor repairs, 1838. Thoroughly repaired 1845, except 130 feet. Repaired, 1846. Thoroughly repaired, 1854. Length of 40 feet rebuilt, 1869. Thoroughly repaired, 1871. Extensive repairs, 1875. Thorough repairs, 1888.

North pier.—Repairs at various times to 1834. Minor repairs, 1838. Repairs, 1843. Nearly repaired, 1844. Repaired, 1846. Seven hundred feet superstructure rebuilt and thorough repairs, 1853. Gale of October, 1867, overturns 300 feet of new work. Repaired and strengthened, 1868. Length of 70 feet rebuilt, 1869. Thorough repairs, 1871. Extensive repairs, 1874–'75. Length of 300 feet rebuilt and protected with piles on channel side, 1877. Length of 389 feet rebuilt, 1878. Three hundred feet damaged by heavy gale, 1878. Minor repairs, 1880. End cut down 3 feet below water by vessel. Three hundred and eighty linear feet strengthened by piles on channel face, 1882. Forty feet at outer end undermined, 1881–'82. Repairs completed, 1883. Minor repairs, 1888.

North breakwater.—Repairs in 1831. Breach made around shore-end, 1832. Closed, 1833. Minor repairs, 1838. Wholly repaired, 1844. Repaired, 1846.

In addition to the above various repairs were made without anything to show where, except that they were on "piers and breakwaters."

Besides the piers and breakwaters at the mouth of the harbor there are the ruined remains of various shore protections and catch-sand jetties that have been built from time to time. None of these structures lasts long.

The piers and breakwaters are all in good condition.

THE CHANNEL.

It is hard to find out the original condition of the channel entrance. The survey of 1819 reports a bar across the mouth of the harbor with 6 feet of water on it. In 1828, after the piers had been prolonged to the bar, it is reported as having been narrowed from 900 to 200 feet, and the "depth increased from 2 to 5 feet." In 1829 the first project is reported as completed, the channel being deepened from "its original depth of 1.5 feet to 7.5 to 15 feet." In 1830 it is reported 9 feet deep; 12 feet in 1833 and 1834. Between 1840 and 1842 it is reported as shoaling. In 1844 it is 18 feet deep between the piers, with the bars outside and inside; depth on them not given. In 1845 a channel was dug through the bars 150 wide and 10 feet deep. Entrance shoaled between

1846 and 1852. In 1855 a Board of Engineers recommended widening the channel to 500 feet. In 1857 the channel had filled up so that "17,000 cubic yards of sand will have to be removed from the inner bar and 10,000 cubic yards from the outer bar, to let vessels come drawing 9 feet." No work having been done the outer bar had shoaled very much in 1864, but depth of water is not stated. In 1867 the channel is reported 200 feet wide and 14 deep through outer bar. In 1868 it is 100 feet wide and 13 feet deep, and in 1869 200 feet wide and 14 deep through inner bar. In 1870 it keeps same width and depth through both bars. In 1876 it is reported 12 feet deep. In 1879, 200 feet wide and 15 to 16 feet deep. In 1880, 350 feet wide and 18 deep. In 1882 the channel is 16 feet deep, 300 feet wide through outer bar and 350 feet through inner bar. In 1884 the channel is reported 300 feet wide and 17 feet deep. In 1887 it is 350 feet wide and 16 feet deep over inner bar and 19.5 to 20 feet over outer bar. June 30, 1888, the channel is 350 feet wide, 19 feet deep on outer bar and 16 feet deep on inner bar.

Since 1867 the following amounts of dredging have been reported.

	Cubic yards.
From the outer bar	97,666
From the inner bar	150,077
From both bars, amount from each not given	222,631

THE PENINSULA.

The various structures put up for the protection and defense of the shore-line of the peninsula have almost entirely disappeared. Here and there are scattered a few ruined piles. The structures themselves have no longer an existence.

The changes that have taken place here are of great importance. It may be well to look back at what has been done.

During the fall and winter of 1828–'29 a breach occurred at the neck. Its location and extent are not stated. All the appropriation was spent in closing it. In 1832–'33 another breach was made. Nothing seems to have been done to close it, and in 1835 it is reported as nearly a mile wide. Lieutenant Brown proposed to partly close the breach and to make a western entrance 400 feet wide to the bay. In 1836 a crib breakwater was built 420 feet long, strengthened with piles and filled with stone, to close the breach. This was extended in 1837 to a total length of 2,320 feet, or one-third the length of the breach. In 1838 there was built a length of 570 feet of crib-work north of the proposed entrance and 465 feet south thereof. In 1839, 300 feet north and 690 feet south were built. Up to this time there had been put in a total length of 4,265 feet of crib-work. On account of no appropriations having been made no work was done until 1844, when it was reported that part of the crib at the west end of the breach was destroyed, and that the breach was narrowed to 3,000 feet, with a depth of 5 to 6 feet. In 1852 the breach is reported as still existing and the cribs almost destroyed. In 1853 the shore of the neck was revetted with brush and stone with satisfactory results. This mode of closing the breach was continued in 1854–'55,–'56. No further mention of this breach is made until 1864, when it is reported as closed. During the year ending June 30, 1872, there were planted along the neck 50,000 young trees and slips. In 1875 the experiment was declared a failure. A gale in November, 1873, made a new breach. This was closed in 1874–'75 by a pile and plank fence strengthened with stone. During 1876 the same construction was continued as a protection with excellent results. On June 30,

1877, this protection is reported as 6,547 feet long. In 1880 the beach of the neck is reported as much damaged. A contract was made to repair the fence. In 1881 these repairs were made and 8 jetties 200 feet apart were added to catch the sand and build out the beach; 2,000 linear feet of brush and stone shore protection was renewed. During this year the fences were much damaged by gales. Protection much damaged during winter, 1881–'82. Repairs made by close piling during 1883. Nothing done since. In November, 1886, the shore protection end jetties were a lot of wrecks.

During the autumn of 1887 and the early winter following much damage was done to the lake shore of the peninsula, at one point the encroachment of the water being as much as 200 feet. On May 29, 1888, advertisements were published asking for bids to build a protection 6,000 feet long. Bids will be opened on July 2.

CATCH-SAND JETTY.

A jetty was built 3,000 feet north of the north pier, for the purpose of arresting the movement of sand, during the summer of 1883. On August 28, 1883, it was 770 feet long. On August 29, 420 feet at the outer end was destroyed by a storm. This was rebuilt. November 12 and 13, 1883, saw 280 feet wrecked. Nothing has been done since.

REPORT OF OPERATIONS.

The operations of the past year have consisted of a thorough overhauling of the piers and breakwaters and of a survey of the peninsula.

The severe gales of the fall and winter of 1886–'87 had done much damage, especially to the south breakwater, which was breached at four points. These breaches were all closed up by rebuilding the breakwater at these points, replacing cribs where necessary, and renewing superstructure. The breaches were located as follows:

	Feet.
No. 1, from station 0+30 to station 1+30	100
No. 2, from station 4+27 to station 4+82	55
No. 3, from station 5+95 to station 7+00	105
No. 4, from station 14+10 to station 15+00	90

Distances are estimated southwardly from the intersection of the north face of the south pier with the west face of the south breakwater.

In addition to these breaches extensive repairs were made to the south breakwater and to the south pier and a few planks renewed on the north pier.

The survey of Erie Harbor ordered by letter from the Chief of Engineers, dated November 26, 1887, was at once put into execution. Owing to the excessively cold weather and the heavy ice of the past winter full operations could not be begun until April 23, 1888. After that time they were pushed hard. The field work was finished on June 16, 1888, and the party discharged.

The cost of the repairs to the breakwaters and piers was:

Materials:		
Timber	$1,346.68	
Iron	125.89	
Stone	715.16	
Total materials		$2,187.73
Supplies		6.05

Labor:		
Removing timber in old work	$65.49	
Removing stone in old work	33.21	
Unloading, transporting, and handling timber until it reaches the work	102.99	
Framing and placing timber in position	500.03	
Unloading, transporting, and handling iron until it reaches the work	9.59	
Placing iron in work, this to include labor boring holes for bolts and spikes and driving them	33.96	
Removing old piles	3.30	
Unloading, transporting, and handling piles until they reach the driver	25.40	
Labor and machinery used in driving piles	137.90	
Handling stone	27.00	
Handling and placing timber in position	166.28	
Miscellaneous jobbing	31.98	
Total labor		$1,137.14
Time of inspector		625.00
Tug		5.00
Total		2,860.91

PROPOSED OPERATIONS.

Bids for building the shore protection of the peninsula will be opened on July 2. So much of this work as the present state of appropriation will allow is contemplated for the present season. Should an additional appropriation become available it is proposed:

(1) To extend the shore protection so as to protect all of the weak points of the neck of the peninsula.

(2) To do such dredging as the survey just completed may show to be necessary in the entrance to the harbor so as to give a channel suitable for vessels drawing 16 feet.

(3) To build on the east shore of the peninsula, north of the north pier, a catch-sand jetty, extending to a depth of 25 feet or to a point where the depth is sufficiently great to be beyond the reach of the forces that cause the movement of sand along the shore, subject to approval by the Secretary of War and the Chief of Engineers.

REMARKS.

This harbor is unquestionably the best natural haven on Lake Erie. Once within it there is ample space for many vessels to lie and have plenty of water under them. Being wholly surrounded by either natural or artificial protections its waters can never be disturbed by storms sufficiently to endanger vessels lying therein, whether at the dock or at anchor.

The prevailing winds are from the westward. They come from this direction more frequently and with greater force than from any other.

The protection to the west and north is merely a neck of sand which is constantly undergoing change by the action of the wind and waves. Three times since 1827 this neck has been breached and three times it has been closed. The second breach remained open for about thirty years. It was partly closed by works constructed for the purpose, but the remainder of the operation seems to have been brought about by natural causes. It is impossible to say how long it may be before another breach will be made. At present, indications are against it hap-

pening very soon. The works constructed up to the present time have been but temporary in their character, as must necessarily be the case with all timber structures in like situations unless they be carefully maintained. Even when new they are exposed to accidents which may in a night destroy the labor of weeks. As an example of the rapidity with which these works disappear may be cited the jetties built in the autumn of 1881. In the autumn of 1886, only five years after, they were merely a lot of broken stumps of piles. In fact it may safely be said that any timber structure placed to protect the neck must be built over new every six or seven years.

The movement of the sand eastwardly around the point of the peninsula is a constant menace to the harbor. Carried around the point by currents developed by the winds it is dropped in the eddy formed by the north pier, and in a short time theo uter bar is formed. A strong southwesterly gale comes up. The water in the lake is raised above the water in the bay. It rushes with great speed from the former to the latter. The sand from the outer bar is deposited inside the bay. When the lake falls the direction of the current is reversed. Some but not all of the sand is carried back. The channel between the piers is always deep (in some points this depth is as great as 40 feet), but the bars gradually shoal. Up to the present time dredging alone has been tried as a remedy. Since 1867 over 500,000 cubic yards of sand have been removed. It is safe to say that none of this work was done for less than 25 cents a yard. To keep the entrance clear, then, has cost $125,000, or an average of more than $6,000 a year. To be sure, much of this was spent in obtaining the channel. Since 1880, when the channel was reported 350 feet wide and 16 feet deep, 80,000 cubic yards, in round numbers, have been dredged. This is 10,000 cubic yards a year, or $2,500. This represents the interest at 5 per cent. on $50,000. Can a permanent structure be built for this sum? Will there be no future accretions of sand at the mouth of the harbor if such a structure be built? These are questions which the survey now about completed is expected to give the means of answering.

Money statement.

July 1, 1887, amount available		$80,351.78
Amount deposited to balance account		.04
		80,351.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,937.28	
July 1, 1888, outstanding liabilities	530.32	
		7,467.60
July 1, 1888, balance available		72,884.22
Amount appropriated by act of August 11, 1888		23,000.00
Amount available for fiscal year ending June 30, 1889		95,884.22
Amount (estimated) required for completion of existing project		23,620.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		127,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Erie, Pa.; collection district, Erie, Pa.; nearest work of defense, Fort Porter, N. Y.; nearest light-house, Erie, Pa.

The Erie Light stands on a bluff of the lake shore to the eastward, andjust outside of Erie Harbor. It is a fixed white light of the third order. It is 128 feet above the level of the lake, and is visible at a distance of 19 miles. Its position is in latitude 42° 08′ 42″ north, and longitude 80° 03′ 46″ west.

The Presque Isle Beacon is at the east end of the north pier at the entrance to Presque Isle Bay. It is a fixed red light of the fourth order. It is 39½ feet above the level of the lake, and is visible at a distance of 12½ miles.

The Erie Range Beacon No. 1 is at the west end of the north pier at the entrance to Presque Isle Bay. It is a fixed white light of the sixth order. It is 16¾ feet above the level of the lake, and is visible at a distance of 9½ miles.

The Erie Range Beacon No. 2 is 908 feet from No. 1. It is a fixed white reflector light. It is 45 feet above the level of the lake, and is visible at a distance of 13 miles.

The Presque Isle Light is at the north shore of the peninsula, 3 miles by water westward from the entrance to Presque Isle Bay. It is of the fourth order, flashing alternately red or white with an interval of ten seconds between the flashes. It is 57 feet above the level of the lake, and is visible at a distance of 11 miles.

Arrivals and departures of vessels during the year ending December 31, 1887.

Description.	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers:				
Passenger	20	21,000	20	21,000
Freight	374	568,688	384	604,107
Barges:				
Steam	20	16,000	15	12,000
Towed	14	7,000	16	8,000
Sailing vessels	175	96,034	183	97,938

Amount of revenue collected during year ending December 31, 1887 ..... $5,973.65
Value of imports same year 64,796.12
Value of exports same year 200.00

Greatest draught of vessels, 16 feet. No vessels from or to foreign ports.

L L 2.

IMPROVEMENT OF DUNKIRK HARBOR, NEW YORK.

Object.—To form an artificial harbor by means of a detached breakwater, a pier running out from shore, and an excavated channel giving a passage-way for vessels drawing 12 feet.

Project.—The original project for this harbor was adopted in 1827. It varies little from the one in use at the present time, which provides for a channel 13 feet deep and 170 feet wide; for a detached breakwater in two connected parts, one lying east and west, very nearly, 2,300 feet long, the other 560 feet long and parallel to the channel, and a pier leading westwardly from the beacon on the west side of the channel to the shore.

Present works.—The present works consist of a pier and an unfinished breakwater, both in bad condition. The following table shows the course of construction of each:

Year.	Pier.		Breakwater.		Channel.		Remarks.
	Extended.	Total length.	Extended.	Total length.	Width.	Depth.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1867	.....	.....	.....	.....	.....	.....	Contract made to rebuild the pier on the foundation of the old work and to extend it to the beacon.
1868	454	454	.....	.....	.....	.....	
1869	926	1,380	210	210	.....	.....	
1870	.....	.....	180	60	.....	.....	330 feet of breakwater carried away by gales in fall of 1869.
1872	.....	.....	210	210	.....	.....	Day beacon built; bar formed at entrance of channel.
1873	.....	.....	150	360	.....	.....	180 feet of breakwater additional without superstructure; bar cleared from channel.
1874	.....	.....	.....	.....	.....	.....	Superstructure continued on breakwater; 2,375 cubic yards of rock and 8,500 cubic yards of sand taken from channel.
1875	.....	.....	60	420	.....	.....	120 feet of superstructure incomplete.
1876	.....	.....	330	828	.....	.....	There seems to be no way to explain the discrepancy between the extension and the total length of the breakwater, which is this year reported as here given; 4,465 cubic yards of rock removed from the channel.
1877	.....	.....	.....	940	.....	.....	Pier damaged by gale; repaired.
1878	.....	.....	250	1,191	.....	.....	Cribs 50 feet long, 30 feet wide, 8 feet high.
1879	.....	.....	.....	.....	.....	.....	Schooner loaded with 480 tons limestone wrecked in middle of channel; wreck abandoned and removed.
1882	.....	.....	.....	1,191	.....	.....	Three cribs, 50 feet by 30 feet, put in without superstructure.
1883	.....	.....	150	1,341	.....	.....	Superstructure placed on cribs sunk last year.
1885	.....	.....	.....	.....	170	13	Repairs of breakwater begun; 13,318 cubic yards of materials removed from channel.
1886	.....	.....	.....	.....	.....	.....	Repairs of breakwater finished; 23,316 cubic yards removed from channel.
1887	.....	.....	.....	.....	.....	.....	Great damage to pier by gales of fall and winter; 259 feet carried away.
1888	.....	1,380	.....	1,341	.....	.....	Pier partly repaired.

NOTE.—First appropriation in 1827. In 1832 the breakwater was 2,564 feet long and the pier 1,400 feet long. In 1838 there had been completed 2,125 feet of breakwater and 300 feet of detached breakwater. In 1848 the breakwater was demolished.

DAMAGES AND REPAIRS.

1. *Pier.*—Two hundred and ten feet of foundation cribs carried away October 7, 1868—repaired following season. Much damage done by fall gales of 1869—repaired same season and further damage done. Strengthened 1871. Damage by gale, 1877—repaired. Thorough repairs, 1879, for length of 993 feet from beacon. Two hundred and fifty-nine feet of pier from beacon carried away during fall and winter 1886–'87. Partly repaired during summer of 1887. Two-thirds of new work carried away October, 1887. Ninety linear feet of breach of 1886 rebuilt.

2. *Breakwater.*—Of the 390 feet of cribs laid in 1869, 330 were carried away the same fall. Considerable damage done by gales during fall of 1886. Partly repaired. More damage in 1887.

CHANNEL.

No work has been done in the channel since 1886, when over 23,000 cubic yards of material were removed. Depth of 13 feet thus obtained.

REPORT OF OPERATIONS.

Work during the past season consisted in trying to rebuild the part of the west pier carried away by the gales of the fall and winter of 1886–'87 and in such repairs to the breakwater as could be made.

Under instructions from the Chief of Engineers the repairs to the pier were made by sinking new cribs, nine in number, varying from 4 to 7 feet in height, on top of the ones left after the gales of the preceding fall and winter. These new cribs were very solidly built, and in addition to the usual construction followed in such cases large iron bolts 2 inches in diameter and 7 feet long were used to fasten the new work to the old. In no case did these long bolts penetrate less than 2 feet into the timber of the old cribs. These cribs were almost finished when came the gale of October 3 and 4, 1887, and tore out three of them. Before the materials could be had for repairs the storm of October 23 and 24 carried out three more. When the materials arrived they were employed in placing the superstructure on the cribs which remained and in securing them for the winter.

On the breakwater a great deal of the harbor wall was rebuilt. About one-fourth of the deck joists and plank were replaced.

COST OF THE WORK.

Materials:		
Timber		$2,750.74
Iron		864.30
Stone		2,053.20
		5,668.24
Tools		3.18
Supplies		12.25
Labor:		
Removing timber in old work	$13.45	
Labor unloading, transporting, and handling timber until it reaches the work	25.00	
Framing and placing timber in position	1,276.88	
Labor placing iron in work, this to include labor boring holes for bolts and spikes and driving them	411.48	
Tearing out wreckage	39.90	
Labor handling stone	864.79	
Labor handling and placing timber in position	229.57	
Miscellaneous jobbing	443.66	
Boatman engaged in making soundings	5.00	
July pay-roll	376.95	
		3,686.68
Total		9,370.35

The time books were not received in time to note the distribution of labor during the month of July.

CONDITION OF THE WORKS.

In the pier is a breach 169 feet long west from the beacon. The rest of the pier to the shore is in bad condition. The lake slope timbers were so rotten a year ago that the wood could be pulled to pieces with the fingers. To rebuild what is now destroyed and to make absolutely necessary repairs will cost at least $15,000.

The breakwater needs to be rebuilt. It is now in such condition that any attempt at ordinary repairs will be a waste of money, as such repairs can only consist of replacing the more rotten timbers with sound ones. It will be much less costly to do the work systematically than to try to patch it. To do this work will cost $75,000.

PROPOSED OPERATIONS.

In the present condition of the funds for this harbor no work is practicable. Should another appropriation be made it is proposed to extend

it as follows: (1) Clear out entirely the space between the part of the west pier now standing and the beacon, and rebuild the existing breach. (2) Thoroughly overhaul and rebuild so much of this pier as may require such work. (3) Begin rebuilding the breakwater.

REMARKS.

Dunkirk Harbor is particularly ill-adapted for the requirements of navigation as they exist at the present time. It is simply an indentation in the shore-line of the lake. The general direction of this line passes entirely outside of the sort of pocket thus formed. The curve of 18 feet depth of water lies 500 feet out from the shore-line west of the pocket, and 1,000 feet from the shore-line to the east thereof. The direction of this curve across the pocket is, as nearly as may be, a straight line. The curve of 12 feet depth of water bends very slightly towards the shore. There is no point within the general line of the shore, produced across the indentation, accessible to vessels such as are now ordinarily employed in the navigation of Lake Erie. Of these there are few which draw when loaded less than 14 feet. To obtain sufficient water to float vessels of this sort would require an excavation all over the harbor at least 3 feet in depth, and averaging nearly if not quite 6 feet. Part of this material is sand and gravel, much of it is rock.

The prevailing wind along this part of the shore of Lake Erie is from the southwest. Under its influence much material is transported along the shore of the lake, and what comes as far as Dunkirk Harbor is there deposited. This action is clearly seen in the changes of the shore-line adjacent to the west pier. Since this harbor was assigned to my charge this line had moved about 150 feet toward the beacon at the time of my last visit, January, 1888, an interval of sixteen months. Inside of the west pier the shoaling goes on rapidly.

To maintain a harbor at this point will, after it is once made, require unceasing labor. I have no means of determining the amount of the deposit which takes place here from year to year. This would require a careful annual survey. It is not necessary to make such a survey as a mere glance at the shore-line, from time to time, shows that it is rapidly moving lakeward along the west side of the indentation.

Along the water front of the city the shore has suffered much from the action of waves during storms. The city has taken the matter in hand and has driven a row of piles across the worst part of the damaged section. The piles are 5 or 6 feet apart. On the shore side planks have been spiked, forming a face from 1 to 3 feet high. As the shore inside of these planks builds up by materials thrown over by the waves another width of plank is added. The system is apparently successful.

Money statement.

July 1, 1887, amount available	$8,299.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,709.01
July 1, 1888, balance available	1,590.22
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,590.22
Amount (estimated) required for completion of existing project	25,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Dunkirk Harbor, New York, is in the collection district of Dunkirk. It is lighted by a third-order fixed white light varied by a white flash every ninety seconds, and by a sixth-order fixed white beacon light. The main light is visible from a distance of 16½ miles and the beacon from a distance of 12½ miles.

There are three spar buoys—one black, two red.

The nearest work of defense is Fort Porter, N. Y., 40 miles to the eastward.

The following table shows the commercial movement for the year ending December 31, 1887:

Description.	Entered.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Home ports:				
Passenger steamers	1	267	1	267
Steam-barges	3	843	3	843
Towed barges	10	3,352	10	3,352
Foreign ports, passenger steamers	2	534	2	534

Amount of revenue collected during year ending December 31, 1887, none; value of imports same year, none; value of exports same year, none; greatest draught of vessels, 13 feet.

L L 3.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

ORIGINAL CONDITION OF THE HARBOR.

Up to 1868, when the detached breakwater was begun, Buffalo Harbor and Buffalo Creek may be considered as synonymous terms.

The earliest record of which I can gain any trace as to the condition of this harbor as to navigability was in 1818, at which time the mouth of the creek (Buffalo) was most of the year closed by a gravel-bar, which cut out in freshets and then closed up again.

PROJECT.

Project of 1819.—The first project for improvement was in 1819, when, under the auspices of the State of New York, arrangements were made for improving the mouth of the creek by two parallel piers, which were built in 1820–'21, the south pier being about 1,300 feet long and the north pier 1,000 feet.

In 1826 the works passed to the control of the United States.

Project of 1830.—In 1830 it was determined to construct a cross or sea wall nearly at right angles to the eastern end of the mole (south pier, F. A. M.) * * * to prevent the sea from making a breach.

Project of 1835.—This project was to continue the Black Rock breakwater from Bird Island to the southward to a point 1,000 feet north of the new light-house. This project was never adopted.

Project of 1837.—This was to extend the sea-wall southwardly.

Project of 1839.—This project was to extend the south pier to 22 feet of water and to construct a detached breakwater 330 yards long from a point 500 feet north and 300 feet east of the end of the extended pier.

Project of 1844.—In this year General Abert proposed a breakwater on the Horse-shoe Reef about 2,650 feet from the northern shore; the breakwater to be 3,700 feet in length, its westward end 2,100 feet from

Black Rock pier, and its eastern end about 800 feet from a proposed extension of the present south pier. * * * This would give a harbor 7,400 feet long, 2,100 feet wide, with 14 feet to 20 feet of water.

Project of 1845.—In 1845 a Board of Engineers considered two projects for an outer harbor: (1) A detached breakwater 5,100 feet long, to the north of the light-house pier; and (2) a detached breakwater, south of the light-house pier, 6,050 feet long, the north end 2,500 feet south-southwest of the end of the light-house pier and the south end about 3,600 feet from shore.

The Board recommended the south breakwater as the more suitable, but stated that it might become necessary at some future day either to build the north one or extend the south one to Four-mile Point, or connect its southern end with the shore.

Project of 1867.—In June, 1867, General Cram submitted a project for the "enlargement and repair of the existing harbor." This project was modified in December, 1867, and the modification was referred in 1868 to a Board of Engineers, who decided on the following plan:

(1) To extend slightly and thoroughly repair the north pier.

(2) To repair the south pier.

(3) To extend the south pier 318 feet from the north side of the light-house.

(4) To dredge between the extension of the south pier and the prolongation of the north pier so as to get 14 to 15 feet at low water.

(5) To construct a detached breakwater in about 27 feet of water, beginning at a point in the prolongation of the south pier and 2,500 feet from the light-house, thence running southwardly on a line parallel with the shore for 4,000 feet; the structure to be of crib-work filled with stone and decked with plank; to have a rectangular cross-section; the width in 29½ feet of water to be 34 feet and in no case to be less than the total height from the bed of the lake to the top of the deck, the top to be 5 feet above the highest water known.

(6) To cut off 212 feet from the south end of the Erie Basin breakwater, provided the legislature of the State of New York should consent.

(7) To cut a canal from a point in Buffalo Creek about 1½ miles south of the south pier to the 14-foot curve in the lake, it being thus 2,820 feet long; to have 200 feet of width, with two close pile-piers 20 feet wide and 5 feet above water, one 1,058, the other 1,000 feet long to protect the channel from the shore to the 14-foot curve.

Of this project the Chief of Engineers only approved (1) the repairs of the piers; (2) theextension of the south pier; (4) the dredging between the north and south piers; (4) the construction of the outer breakwater.

Project of 1874.—The Board of Engineers of 1873 and 1874 recommended the construction of a catch-sand pier, to be formed of a pile-pier 10 feet wide, covered by 6 feet of superstructure and extending to the 12-foot curve in the lake, thence prolonged in the same direction to a total length of 1,270 feet by a crib-work 20 feet wide, having a superstructure 6 feet high, the shore end of the pile-pier to be connected with the railroad bulkhead behind it by a close row of piles. This pier to be begun at a point opposite the south end of Blackwell Canal.

The Board also recommended that the detached breakwater be lengthened 3,600 feet, thus giving a total length of 7,600 feet instead of 4,000 as adopted by the project of 1867. A shore-arm was added, so built as to leave a fair-weather opening of 150 feet between it and the main structure, and to have a direction of 45° with the shore-line until it reached the sand-catch pier prolonged to meet it.

The south channel recommended by the project of 1867 was considered and disapproved by this Board.

Summary.—These various projects with their modifications provide for—(1) Two piers, one on the north and the other on the south side of Buffalo Creek. (2) A masonry sea-wall running southwardly from the south pier. (3) A breakwater parallel to and about half a mile from the shore, its north end being on the prolongation of the south or light-house pier, 7,600 feet long. (4) A pier and shore-arm of the breakwater to close the south end of the space between the breakwater and the shore.

PRESENT WORKS.

The present works consist of—(1) A pier on the north side of Buffalo Creek, known as the North Pier. (2) A pier on the south side of the creek, known as the South or Light-house Pier. (3) A detached breakwater to be, when finished, 7,600 feet long, with a shore arm to be, when finished, 4,100 feet long. (4) A pile-pier built for a sand-catch and eventually to form part of the shore-arm of the breakwater. (5) A sea-wall of masonry to protect the shore from the waves of the lake.

I.—NORTH PIER.

Construction.—Begun in 1819. Continued in 1820–'21. Consisted of a double row of piles filled with brush and sand. Its length at this time is not known. In 1833 it was 1,250 feet long and 15 feet wide, of timber cribs filled with stone.

In 1842 the pier was nearly destroyed. Its length is given as 675 feet at this time. Its length in 1888 is 716 feet to the city dock-line and 775 feet to the end of the pier.

Damages and repairs.—Much damage was done by storm of January 28, 1828. Repaired at various times up to 1840. New pier-head built 1869–'70. Damaged by steamer of Union Steam-boat Company in 1871: repaired at cost of $86.46. No evidence of cost being refunded. Minor repairs in 1877. Delaware, Lackawanna and Western Railway rebuilt by authority of the War Department, 730 feet, in 1879–'80.

Trespass of Delaware, Lackawanna and Western Railway.—Early in 1878 this company began to fill up the ground in rear of and to encroach upon the pier. Encroachment continued and came to a crisis in October, 1879. On December 9, 1879, the company was allowed to remain on the pier under certain conditions. (See Report of the Chief of Engineers for 1880, Part III, pp. 2195–2201.) On October 23, 1884, the company began to carry on further work. After much correspondence the company attempted, toward the end of January, 1885, to carry the work through by force, and was only prevented by the Secretary of War ordering troops from Fort Porter to protect United States property. The matter was finally settled by a supplement dated February 14, 1885, to the stipulation of December 9, 1879. (See Report of the Chief of Engineers for 1885, Part III, pp. 2256–2262.)

II.—SOUTH PIER.

Construction.—Begun in 1819. Continued in 1820–'21. Timber cribs filled with stone extending quarter of mile to 13-foot water in the lake. Protection mole of stone 15 feet above lake level, built in 1828, 240 yards long. Lacked 100 feet of intended length in 1830. New pier-head to serve as foundation for a light-house finished 1831. Length

in 1833, 1,790 feet. Extended 318 feet, timber cribs filled with stones, 1869. Length in 1888 from sea-wall to center of light-house, 1,157 feet; crib extension 318 feet; in all 1475 feet.

Damages and repairs.—Pier nearly destroyed by storm of January 28, 1828. Repaired and straightened in 1830. Repaired in 1836–'38–'40–'53. (No records of work from 1846–'53.) Extensive repairs in 1866. In 1870, extensive repairs to masonry of terre plein; pile protection placed on channel side; repairs to pier-head and leveling up about light-house. In 1877 and 1883, minor repairs. In 1884, superstructure of timber extension rebuilt. In 1885, pile protection renewed.

Considerably damaged by gale of October 14, 1886; repairs not necessary.

Repairs during the fiscal year have consisted of—(1) Replacing some old guard-piles at the end of pier; (2) repairing a break in the timber fender of the pier caused by a vessel striking it during a gale; (3) rebuilding part of the face of the pier where settling had occurred caused by a dredge working too close to the pier some three or four years ago.

The cost of these repairs has been as follows:

Labor		$484.11
Materials:		
Timber	$33.51	
Broken stone	29.99	
Pebbles	32.60	
Sand	18.72	
Portland cement	51.60	
Natural cement	14.14	
Total materials		180.56
Miscellaneous:		
Inspection	93.75	
Derricks	20.25	
Machinery	15.04	
Tug hire	82.50	
General expenses	6.37	
Total miscellaneous		217.91
Total		882.58

The repairs to the south pier are not completed.

III. SEA-WALL.

Construction.—Determined on in 1830. In 1834, 700 feet built. In 1837, length of 1 mile proposed. In 1838, earth mound faced with masonry; top of mound 14 feet above water; 1,900 feet of mound, three parts finished; 400 feet of facing 9 feet high, lacking 3 feet of full height; 250 feet 5 feet high; average width at base 4.5 feet. In 1839, 2,320 feet finished; average width at base for last 840 feet 5.3 feet; 13 feet high. In 1840, extended 1,450 feet. In 1845, plan changed to 8 feet wide at base and for 5 feet in height, then stepped 1.25 feet at regular heights until 2 feet wide, with coping 1 foot thick. In 1866, 1,303 linear feet built; coping on 357 feet. June 30, 1867, 4,080 linear feet finished with coping, 1,319 feet without coping; foundation alone laid for 321 feet.

No work was done after this date except slight repairs.

Cost, up to 1872, $103,305.96.

Damages and repairs.—Slight repairs in 1870. Undermined near south end by storms, winter of 1880–'81.

NO BREAKWATER.

Construction.—Begun in 1860, continued as shown in table.

Year.	Length of cribs sunk.	Foundation finished.	Superstructure laid.	Total completed length.	Year.	Length of cribs sunk.	Foundation finished.	Superstructure laid.	Total completed length.
	Feet.	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*
1869...	150	150	400	.....	1880...	350	3,426	350	3,426
1870...	800	950	400	400	1881...	500	3,926	.....	.....
1871...	750	1,711	783	1,183		200	4,126	.....	.....
1872...	425	2,136	670	1,853	1882...	300	44,37	504	3,932
1873...	263	2,399	231	2,084				504	4,437
1874...	100	2,499	415	2,499	1883...	450	4,891	454	4,891
1875...	.....	2,515	.....	2,515	1884...	.....	.....	.....	.....
1876...	250	2,765	200	2,715	1885...	890	5,696.9	805.9	5,696.9
1877...	150	2,915	200	2,924	1886...	450	6,146.9	200	5,896.9
1878...	150	3,074	.....	.....		200	6,349.8	452.9	6,349.8
1879...	.....	.....	150	3,076					

Present condition June 30, 1888.—250.5 feet concrete, concrete faced. Banquette 4 feet, parapet 13 feet above water. Banquette not quite finished.

201.5 feet concrete, stone faced, incomplete.

1,471.8 feet timber, filled with riprap; needs immediate rebuilding; 5.10 feet above water.

290.2 feet in good condition; timber filled with riprap. Banquette 22 feet wide, 5.10 feet high. Parapet 12 feet wide, 12 feet high.

290 feet in good condition, timber filled with riprap. Banquette of irregular shape, 22 to 45 feet wide. 5.10 feet high. Parapet 12 feet wide, 12 feet high. Old foundation cribs out of place from Station 24 + 4 to 24 + 97 project 12 to 21 feet toward lake. Ice-breaker on lake side 24 + 97 to 25 + 44.

424.4 feet in good condition. Timber filled with riprap. Banquette 22 feet wide, 6.43 feet high. Parapet 12 feet wide and 12 feet high.

151.4 feet, much decayed, no parapet, 38 feet wide, 6.43 feet high.

310.6 feet, much decayed, no parapet, 38 feet wide, 7.43 feet high.

497.6 feet, decayed, no parapet, 38 feet wide, 793 feet high

530.2 feet, fair condition, no parapet, 38 feet wide 7.43 feet high.

478.8 feet, fair condition, no parapet, 38 feet wide, 7.50 feet high.

1,458 feet good. Banquette 24 feet wide, 7.50 feet high.

Parapet 12 feet high, 12 feet wide.

6,355 feet, total length.

The structure consists of timber cribs, 50 feet long and about 36 feet wide, filled with stone and sunk to the bed of the lake.

This substructure was brought to the level of the water above which a continuous superstructure was placed. Materials used: Hemlock for substructure, white pine and oak for superstructure, held together by iron drift-bolts 1½ inches square. Cribs and superstructure filled with riprap.

During the summer of 1872 character of bed of lake began to change. The hard gravel bottom became thinner and an underlying stratum of mud came near the surface. In this soft bottom cribs sunk as much as 4 feet in twenty-four hours. At the end of the working season of 1872, 315 linear feet of cribs were in place without superstructure. During the winter the cribs sank into the mud from 4 to 8 feet and were displaced sideways to a greater or less extent, varying from 4 to 24 feet. The settlement was very uneven. The integrity of the cribs seems to have been undisturbed. Damage repaired by sinking on top of disorganized work an irregular shaped repair crib, from 4 to 24 feet wide and 19 to 6 feet high, covering the whole of the 315 feet. The repair cribs were fastened to the old by two iron tie-rods running through from side to side and piles driven in the corners to bed-rock.

In 1873 the mode of construction was changed. An artificial foundation was made by spreading over the bottoms of the lakes a layer of broken stone which settled in the mud by its weight. It was brought to 4 feet above the bed of the lake. On this foundation two cribs (100 linear feet) were built, and a superstructure placed on them and on the displaced work of the preceding season. A gale on December 4, 1873,

laced these two cribs, wrecked 150 feet of superstructure, and aged all of the superstructure built in 1872 and 1873. The 315 feet 872 settled still more and with great irregularity. The prepared dation of broken stone sank through the soft clay so completely as lly to be found by sounding.

Board of Engineers convened in the spring of 1874 and again in ust of the same year, recommended that the mud should be dredged o the bed-rock, or sufficiently hard material, for an estimated length ,500 feet, the trench to be 50 feet wide at bottom and to be filled gravel to 3 feet from the top of the trench. The remaining 3 feet filled up with a layer of riprap 50 feet wide at top. This foundaas successful. The greatest depth of mud encountered was 22 during the season of 1878–'79. The hard bottom reappeared within et of the point indicated by the Board. No dredging has been reed since the spring of 1882.

mages and repairs.—Minor repairs have been necessary from time me. The gale of January 3 and 4, 1884, wrecked a length of 800 beginning 2,000 feet from the north end, to such an extent as to ire rebuilding. This was done during the summer of 1884 at a cost 17,396.42. Further repairs were made to the cribs, which went out ne in 1873, at a cost of $12,123.45. In 1882–'83 an ice-breaker crib built on the outside of the breakwater so as to protect the south of the displaced cribs from the ice.

n October 16, 1886, a furious gale badly wrecked a length of about) feet, beginning at the north end. In many places the harbor-wall ne breakwater was completely carried away and several of the ets were emptied of the stone. As early as 1882 Major McFarland reported that the north 2,000 feet needed rebuilding, but nothing ever done.

uring the winter of 1886–'87 the breakwater was greatly damaged e. A length of about 750 feet of the deck of the south parapet crushed in, owing to the lack of strength in the plan adopted in –'84. The face of the structure along the south parapet, and been it and the north, was much injured. All was repaired during mer of 1887.

RECONSTRUCTION OF BREAKWATER.

ne gale of October 16, 1886, left the breakwater in such a ruined lition as to make it imperative to take immediate steps to rebuild it. roject for rebuilding with masonry was submitted by Capt. F. A. an on December 15, 1886. This project was referred to the Board ngineers. They recommended its adoption, with certain changes. ne profile adopted for the new superstructure consists: (1) Of a dation 5 feet high, with a trapezoidal cross-section, of which the and bottom sides are horizontal, the harbor side vertical, and the side forming, with the horizontal, an angle of which the tangent 3. (2) Of a parapet 9 feet high, also trapezoidal in shape, the lake harbor faces making, with the horizontal, an angle of which the ent is 6 : 1.

ne dimensions are given in Plates 9 and 10, Appendix M M 3, Report hief of Engineers for 1887, Part III, between pages 2356 and 2357. my last annual report it was stated the laying of the concrete d begin not later than July 20. As a matter of fact the work did begin until July 30, and then only in an experimental way. There much trouble in getting the machinery adjusted and in good order.

The distance of the work from a machine-shop and the natural difficulties attendant in setting up machinery by men who had never seen anything of the sort and who had no idea of what was to be done caused a further delay of a week. The time was not wholly lost. The men were kept at work mixing by hand. A result, although but a small one, was obtained.

The trouble was due to two causes. (1) The concrete mixer, instead of being here by June 15, as I had hoped, did not come until July 15. (2) I was too anxious to begin. Had I taken a little more time for preparation I should have gained more in the end.

On August 7 everything was in fair working order, with the machinery running successfully.

On August 11 a night force was organized, and thereafter, until near the close of the season, work went on night and day, including Sundays, beginning with September 4. The work closed for the season on November 14.

Character of new superstructure.—As stated in the last Annual Report the new superstructure is to be divided into two parts:

(1) A core of natural-cement concrete, faced all around with Portland-cement concrete 3 feet thick.

(2) The same core faced with stone, 3 feet thick on the lake side and of varying thicknesses on the other sides.

The lengths approved by the honorable the Secretary of War were, for the concrete facing 250 feet; for the stone facing 500. Owing to the lateness of beginning work none of the stone-faced part was finished. A length of 200 feet was built 8.5 feet high. Enough was done, however, to show the great advantage of the concrete in the matter of cost.

Materials used and their cost.—Of the bids received on June 9, 1887, for furnishing various classes of materials, all those for rubble and dimension stone and for sand were rejected as excessive. Under authority of the Chief of Engineers purchases of stone of the second and third classes (from 200 to 2,000 pounds and from 2,000 pounds upward) were made in the open market at $4 per cubic yard for both classes instead of $7.50 and $8.50, the prices bid. Sand was purchased in the same way at 80 cents per cubic yard instead of $1.05 the price bid.

A contract was made with Williams & McConnell, of Buffalo, N. Y., for broken stone, at $1.84 per cubic yard. This arrangement was highly unsatisfactory. Had it not been that I had about a thousand yards broken by hand by our own men we should have been left badly in the lurch. The contractors had undertaken to furnish the stone with a crusher which lacked the capacity necessary for our work. In trying to crowd it to keep up with our demands they overtasked it, with the result of constant breakage and consequent detention and annoyance to the work. The breaking of the stone by hand was a very expensive operation. It cost $2.8636 per cubic yard; loading it on the boats cost $0.3937; making the total cost $3.25¾.

The stone furnished by the contractors was excellent. It was a very hard limestone, well broken and clean, with sharp edges and very angular. A considerable quantity was furnished in small chips which would pass through a half or quarter inch ring. It answered well for pebbles.

The Portland cement used was the "Gibbs," from London, England. It was furnished by Mr. Howard Fleming, of New York, at the rate of $2.09, delivered in Buffalo by canal. Some of it had to be brought by rail on account of delays by canal. This made the average price of the cement bought under the contract (3,000 barrels) $2.168. Some

additional cement purchased cost, delivered by rail in Buffalo, $2.57 per barrel.

The natural cement was furnished by F. O. Norton, of New York, at $1.20 per barrel, delivered by canal in Buffalo.

The pebbles used in the concrete were an afterthought. They were purchased in the open market, by authority of the Chief of Engineers, at $2 per cubic yard.

The cut stone for the face was very expensive. It cost $4 per cubic yard for the stone and, at 16 cents per square foot, $12.4576, for cutting; in all, $16.46 per cubic yard.

DETAILS OF CONSTRUCTION.

Plant employed.—The plant employed in the construction consisted of—

(1) A derrick-scow 92½ feet long, 20 feet wide, and drawing (loaded) 2 feet. On it was a strong derrick fitted with two booms, one for long reaches with light loads, like the stone in the face of the wall, the other for short reaches with a heavy load, like the batches of concrete. Near the stern of this scow was a small shed used as a blacksmith shop. Near the center was a single-cylinder double-drum engine, with the following dimensions: Cylinder 7⅜ inches diameter, 8 inches stroke; drums 14 inches diameter, 20 inches long; spur-wheel on drums 30 inches diameter; pinion, driving both spur-wheels, 6 inches diameter; boiler, vertical, tubular, 36 inches diameter, 6 feet 6 inches long, 60 tubes 2 inches diameter; ordinary working pressure of steam, a little over 6 atmospheres; reach of long boom, 42 feet from foot of derrick-mast; of short boom, 30 feet.

(2) Three scows, each 95½ feet long, 17 feet wide, drawing (loaded) 5 feet. Two of these scows had flush decks; the deck of the third was 3 feet below the gunwales. This third scow was fitted up with a concrete mixer at one end and a platform near the other. The mixer was a hollow cube, made of boiler iron, 4 feet on an edge, and mounted on a shaft which follows the diagonal of the cube. It was driven by a single-cylinder engine of 7 inches diameter of cylinder and 12 inches stroke, acting through a driving belt and gearing. The pulley on the engine was 12 inches in diameter; that at the mixer 28 inches. The spur-wheel, fastened to the mixer shaft, was 24 inches diameter and the pinion driving it 8 inches. The number of revolutions given to the mixer was generally eight per minute.

The platform was 15 feet wide, measured parallel to the axis of the scow. It was 3 feet above the gunwales, or 6 feet above the deck. On one side of the platform was the mortar-board on which the cement paste was mixed. On the other stood the barrels of cement needed for immediate use. From the platform to the end of the scow, a distance of 23½ feet, was an inclined plane as wide as the scow itself. In the center of the platform was a hole 3 feet square.

On the deck was a track leading from underneath the platform to near the frame supporting the mixer.

(3) A small scow, 55½ feet long and 20 feet wide, drawing 3¾ feet.

This scow and the two of the three mentioned in the preceding article (2) as having flush decks were general utility boats, used for transportation of materials of one kind or another. One of the two was kept constantly loaded with stone which had been broken by hand, so as to have a supply ready in case of the contractor failing to be on hand in time, a thing that frequently happened.

(4) The above-mentioned scows all belonged to the work.

In addition to them there was in use during the time the stone masons were at work a small derrick-scow belonging to L. Harbrecht & Co., general contractors at Buffalo. It did good service in setting the stone face of the breakwater. Messrs. Fox & Holloway, contractors for furnishing sand and pebbles, left with the work all summer and fall a large flat of about 300 cubic yards capacity. They brought their materials on smaller scows and unloaded on this large one. Had it not been for this vessel the work would several times have been much hampered.

A couple of small flats were also hired from time to time, as necessity required, for special purposes.

Tools.—The tools used on the work differed in no way from those generally used by contractors, except the concrete-rammers and the wheelbarrows. The rammers were made of cast iron, with a wrought-iron handle. The rammer proper was a square truncated pyramid 5 inches on an edge at the bottom, 3 inches at the top, and 6 inches high. The handle from the top of the rammer was 2 feet 6 inches high. It was bent at the top into a flattened ring of such size as to be convenient to hold with the hand. About 13 inches from the top a cross-piece was welded on so as to be perpendicular to the plane of the ring. The wheelbarrows had the frame of a stone-barrow. On this frame and as near the wheel as possible was permanently fixed a box holding 2 cubic feet. This box was for the purpose of measuring proportions exactly.

Sheeting for the concrete.—To obtain a sheeting or mold suitable for making the concrete sections was quite difficult. It had to be of sufficient strength, not take up too much room, not contain too much material to be exposed to the action of the waves in case of blows or cause serious loss if carried away, be easy of adjustment, and of simple arrangement.

These results were thus obtained. Some wrought-iron knees were made $2\frac{1}{2}$ inches wide and one-half inch thick. The two legs of the knees were bent so as to be at right angles with each other in one pattern and to form an angle of which the tangent is $\frac{5}{3}$ in the other. One leg was 14 inches long and the other 12 inches. At the end of the 14-inch leg there was a square bend with a side 2 inches long. This would give a total development for this leg of 16 inches. In the center of the 12-inch leg was a slot 10 inches long by three-eighths inch wide. Three holes for spikes were in the 14-inch leg.

The knees were attached to the bâtir posts of the bottom part of the structure [slope $\frac{5}{3}$] by means of $\frac{3}{8}$-inch bolts passing through the slot and the post, into which the 12-inch leg was countersunk. The 14-inch leg was placed on the top of the outside timber of the superstructure with the 2-inch turn-down close up against the inner face. This leg was then spiked into place. The bâtir post was then raised up or moved down until its top was at the height where the change of slope was to occur. The top being at the right height the bolts were made fast and the foot of the post thus secured. The top was held by means of a rod, one end of which was fastened to a plank spiked down to the cribs, the other passing through the head of the post and junction block and made fast with a nut and washer. The head of the $\frac{5}{3}$ bâtir post was cut off so that the upper [$\frac{6}{1}$] post could be accurately fitted thereto. The cross-section of the upper post was 4 by 6 inches. The foot was secured to the head of the lower post by means of the junction block on the outside and two cheeks. The latter were spiked to the sides of both posts. The tops of the upper posts were connected together by a tie-rod made in three parts. The center piece had at each

end an eye. The outside pieces were provided with a hook at one end and a screw and nut at the other. The screw passed through the head of the upper post. The posts opposite each other were held apart by a plank nailed to each and the nuts at the ends of the tie-rods adjusted so as to prevent the posts from spreading when the concrete was rammed.

The sheeting was of 2-inch plank spiked to the bâtir posts.

Execution of the work.—The carrying on of work was theoretically very simple, so far as the concrete work was concerned.

The boats were arranged as follows: The derrick boat, which was able to control about one-half of the length of a section (25 feet) without making the shovel-cast too great in spreading the concrete, was placed broadside along and in contact with the harbor face of the breakwater. On this side of the structure it looked toward the north end. In front of it and about 12 feet away in the clear lay the mixer-boat head on to the breakwater. Immediately in rear of the mixer-boat was placed the large float belonging to Messrs. Fox & Holloway, loaded with sand and pebbles. On one side of this float lay one of the scows belonging to the work, loaded with broken stone, to be used in case of failure on the part of the contractors for that material to keep up their supply. On the other side these contractors brought in their float with broken stone when they had it.

When the boats were all in position and securely fastened together runs were laid from the inclined plane at the stern of the mixer boat to the various vessels so that the materials could be conveniently wheeled up.

The operation of making the concrete was then this: The mortar men who were on the platform of the mixer-boat measured out 2 cubic feet of cement and mixed it with enough water to make a rough paste. The other men loaded up their wheelbarrows (which each held 2 cubic feet) with the sand, pebbles, and broken stone required for a batch of concrete. The proportions of these materials varied a good deal on account of the impossibility of keeping up a fixed organization. It rarely happened that there were the same number of men at work on two consecutive days.

When the barrows were all loaded they were brought and dumped into a large box standing on a truck under the hole in the platform. The pebbles were thrown in first, then the sand, and lastly the broken stone. The cement paste was thrown in with the sand.

The box, having been loaded, was run out a track to a point where the derrick could reach it and raise it over the mixer. There it was taken by two men, who dumped its contents into the mixer. Then it was lowered back to its truck and returned to its place under the platform, in readiness for the next load.

The ingredients having been dumped into the mixer, the latter was started and after it had made from five to ten revolutions it was emptied into another box underneath, precisely like the one in which the ingredients had been brought to it. This box was run out from under the mixer so that it could be taken by the derrick, which raised it and swung it out on the work, where it was dumped and its contents spread by the spreaders. The box was returned to its place and the derrick hitched to the first box, which in the meantime had been refilled.

After the concrete had been spread, care having been taken to cast the finer parts of the mixture against the sheeting, so as to have the outside as smooth as possible, it was thoroughly rammed in layers of 6 to 8 inches in thickness.

Two layers could generally be laid in this way over one-half of the

length of a section in one day in the lower part, viz, to the level of the banquette, or in half a day in the parapet.

Two layers were put in at a time in order to avoid shifting the position of the boats, except at the beginning or end of the working hours, as it was found that to do so in the middle of the morning or afternoon demoralized the gangs more or less and there was consequently some friction in starting again.

With full gangs it was found that a batch of concrete could be placed in rather less than five minutes. In other words, fourteen batches have been laid, spread, and rammed in one hour, but to do it required twelve men for ramming alone. This number of rammers was rarely to be had. The average for the entire season was about 7 batches per hour.

The construction of the stone face was very simple and differed in no respect from the ordinary methods of carrying on masonry.

Difficulties experienced.—(1) The greatest difficulty encountered was the instability of the boats. If there happened to be any sea they would rock, of course. As no two boats could move alike the runs were constantly thrown out of place and at times it was necessary to adjust them just before running out each batch of materials. The managing of the boxes containing the concrete was exceedingly troublesome under these circumstances. As a great deal of the material was deposited when the boom of the derrick-boat was out at right angles to the side of the scow and the boom was 30 feet long, it can well be seen that a comparatively small oscillation of the boat would be much amplified. In fact I have seen the box containing the concrete having a vertical motion of 5 or six feet, caused by the swell. The dump was dangerous. Fortunately no accident happened. At times men would have to knock off from sea sickness. (2) The next difficulty encountered was the crib on which the breakwater light stands. Its position is such that the whole of the first section and the north half of the second were inaccessible from inside the breakwater. It was consequently necessary to move the whole fleet to the outside. To make this move required about three hours. Sometimes the boats were scarcely in place before the wind would come up so rapidly that they would have to be brought back for fear of accident. They were occasionally kept on the outside for some time after prudence directed their being returned. (3) The next difficulty arose at the salient angles of the concrete at the bottom of the structure. Cement requires a certain length of time in which to set. While this was taking place some of it would be washed out by the swell caused by passing boats, if not by the wind, and the angles would crumble. Every way that the ingenuity of the force could devise was adopted to try and prevent this wash until the cement could set. Not one was successful. The least unsuccessful was to sheet the angle at the foot with tarred paper and crash inside of it. With this system the wash was less than with any other. It is useless to mention what did not succeed. (4) The only difficulty encountered on the masonry was with the vertical joints at and under the water-surface, where the mortar was washed out when there happened to be any swell. This was readily overcome by laying a piece of linen crash half under each of the stones alongside of the joint and projecting out from the wall sufficiently far to allow it to come up and cover the entire face of the joint. A lump of rich mortar, 1 sand to 1 cement, was placed in the sort of bag thus formed. A part of it was worked into the joint with the fingers and the rest of it left outside, so that while it was washing slowly away the mortar in the joint would have time to set. (5) A final difficulty was found in getting the Portland cement out from New York. I was

not aware that the cement, as it was imported from England, was distributed direct from the foreign vessels to the lines of internal transportation. The result of this was that an order sent for cement about a month before it was needed here reached New York just after the arrival of a vessel. It had then to wait two weeks until the arrival of the next. Some of it was then ordered to be sent by rail, *via* the Delaware, Lackawanna and Western Railway, in order to be sure of getting it in time. This company left the cement on the dock in New York for an entire week after receiving the shipping order. The consequence was that the cement came three days after the previous supply was exhausted.

The first of these difficulties can be overcome by means of a large float of such size that all the materials, machinery, etc., can be put on it and have thus a good and efficient arrangement in place of one which, while it answered a certain purpose, was unquestionably very inferior.

The second difficulty will not be encountered again.

The third difficulty will be avoided by the use of blocks made on shore and not placed on the breakwater until they have become thoroughly hard. The Chief of Engineers has authorized the construction of such blocks so that the experiment may be tried.

The fourth difficulty will exist so long as masonry is set in the water.

The fifth will be avoided by having all the cement sent out at once, and stored where it can be conveniently reached.

Weather.—The weather as a rule was favorable for carrying on the work. Two severe gales, of which diagrams are given, did some damage, which will be mentioned further on.

COST OF THE WORK.

The total cost of the labor of reconstruction was $21,822.77 for the entire year. To this should be added the cost of the labor for the year ending June 30, 1887, amounting to $2,016.73, making the total cost of labor for the reconstruction $23,839.50 to June 30, 1888.

As a good deal of this labor was performed in handling material which has not yet been used the true net cost of the labor does not appear for the work done to date.

The following cost of the reconstruction of the breakwater was made up to April 1, 1888. As no work has been done on this reconstruction since November, 1887, the figures may be allowed to stand.

The expenditures on account of the reconstruction are as follows, to April 1, 1888:

Materials:		Labor:	
Cement	$10,271.87	Tearing down old work	$2,818.66
Broken stone	3,188.44	Masonry	5,392.33
Dimension stone	2,614.50	Concrete	15,130.92
Cut stone	1,112.48		
Pebbles	5,775.20	Total labor	23,341.91
Sand	900.00		
Iron	616.24	Machinery	1,810.11
Timber	461.31	Miscellaneous	26,098.86
Total	24,940.04		

SUMMARY OF EXPENDITURES.

Materials	$2,940.04
Labor	23,341.91
Machinery	1,810.11
Miscellaneous	26,098.86
Total	76,190.92

From this figure must be deducted the following items of materials, plant, tools, etc., on hand:

Boats	$6,000.00	Stone cutting	$7,219.32
Tools	200.00	Dimension stone	920.00
Plant	300.00	Pebbles	197.00
Machinery	782.00	Broken stone	40.00
Cement	1,656.00		
Cut stone	1,112.48	Total	18,426.80

Total expenditures	$76,190.92
Value of material, etc	18,426.80
Net cost	57,764.12

The concrete-faced part of the work, 250 feet in length, is practically finished. The stone-faced part, 200 feet long, is more than two-thirds done. This gives the equivalent of 383 lineal feet finished. Hence the cost per foot is $150.82.

To determine the cost per cubic yard of concrete and masonry the following data are necessary:

(1) The work is divided into sections of 50 feet in length each, corresponding to the cribs of the substructure. The sections are numbered consecutively, No. 1 being at the north end.

(2) The area of cross-section of the superstructure is 334 surface feet.

(3) Sections 1, 2, 3, 4, and 5 are all faced with Portland cement concrete on the front, top, and back faces, and on the south end. Section 1 is also faced with Portland cement concrete on the north end. The thickness of the Portland cement is 3 feet.

(4) Sections 6, 7, 8, and 9 are faced with stone on the lake side and on the harbor side of the banquette.

(5) The interior mass of sections 1, 2, 3, and 5 is of natural cement concrete; that of 6, 7, 8, and 9 is of Portland cement concrete.

With these data we find—

	Cubic yards.
In section 1:	
Portland cement concrete	324.77
Natural cement concrete	293.74
Total in section	618.51
In each of sections 2, 3, 4, and 5:	
Portland cement concrete	304.54
Natural cement concrete	313.96
Total in each	618.50
In the four sections:	
Portland cement concrete	1,218.16
Natural cement concrete	1,255.84
Total	2,474.00
In all five sections:	
Portland cement concrete	1,542.93
Natural cement concrete	1,549.58
Total	3,092.51

In order to complete the banquettes of these five sections 120 cubic yards of Portland cement concrete are needed. This leaves a total of 1,422.93 cubic yards in place.

Sections 6, 7, 8, and 9 are completed to a height of 8.5 feet only. The area of cross-sections of these sections is 229.5 square feet, of which 25.5 square feet are in the masonry of the lake face, 13.5 square feet in the harbor faces, and 190.5 square feet in the concrete interior.

	Cubic yards.
In each section we have:	
Of lake-face masonry	47.22
Of harbor-face masonry	25
Of concrete	352.77
Total	424.99
In the four sections we have:	
Of lake-face masonry	188.88
Of harbor-face masonry	100
Of concrete	1,411.08
Total	1,699.96

From the concrete must be deducted 46.3 cubic yards for the unfinished banquette of sections 8 and 9, leaving 1,364.78 cubic yards in place. Taking all these quantities together we have:

		Cubic yards.
Portland cement concrete, sections 1 to 5		1,422.93
Portland cement concrete, sections 6 to 9		1,364.78
Total Portland cement concrete in place		2,787.71
Total natural cement concrete in place		1,549.58
Total concrete in place		4,337.29
Estimated loss by storms:		
Portland	150	
Natural	600	
		750.00
Total concrete made		5,087.29
Portland cement concrete made		2,937.71
Natural cement concrete made		2,149.58
Total concrete made		5,087.29

In the concrete there is a quantity of large stone. Just how much can not be said. It is at least 300 cubic yards. This leaves of concrete 5,087.29—300=4,787.29 cubic yards. To make this 5,797 batches were made, giving 0.8258 cubic yards to the batch.

The materials used were:

Portland cement, at $2.168	barrels	2,383
Portland cement, at $2.57	do	193
Natural cement, at $1.20	do	1,383
Sand, at 80 cents	cubic yards	946
Pebbles, at $2	do	2,789.6
Broken stone, at $1.84	do	1,778
Broken stone, at $3.25¾	do	949

These prices give the following results:

	Portland cement concrete.	Natural cement concrete.
Cement:		
2,383 barrels, at $2.168	$5,166.34	.....
193 barrels, at $2.57	496.01	.....
1,383 barrels, at $1.20	.....	$1,659.60
Sand	437.02	319.78
Pebbles	3,221.77	2,357.43
Broken stone	1,841.20	1,347.24
Do	1,785.10	1,306.19
Labor	6,952.43	5,087.22
Total	19,899.87	12,077.46
Cubic yards in place	2,937.71	2,149.58
Cost per cubic yard	$6.774	$35.62

Cost of concrete-faced part, 250 feet long, per running foot.

1,422.93 cubic yards Portland cement concrete at $6.774	$9,639.37
1,549.58 cubic yards natural cement concrete at $5.62	8,708.64
Total	18,348.01

$$\frac{18,348.01}{250} = \$73.392 = \text{cost per foot.}$$

Materials in a cubic yard.

		Portland cement concrete.	Natural cement concrete.
Cement	barrels	0.877	0.649
Do	cubic feet	3.288	2.431
Sand	do	5.021	5.021
Pebbles	do	14.805	14.805
Broken stone	do	14.473	14.473
Total	cubic feet	37.587	36.719

The masonry-faced part is unfinished.

The cost of cutting the stone was 16 cents per square foot. The number of square feet paid for is 59,827. The number of cubic yards of cut stone built, on hand, and lost is 780.93. Square feet cut for 1 cubic yard, 76.61. This, at 16 cents per square foot, gives $12.4576 per cubic yard.

The cost of the masonry, then, is:

258.88 cubic yards stone, at $4	$1,035.52
188.88 cubic yards cut stone, at $12.4576	2,352.99
617 barrels Portland cement, at $2.168	1,337.06
179 cubic yards sand, at 80 cents	143.20
Labor	5,392.33
Total	10,261.70

The length of the masonry face is 200 feet. The cost per foot is $10,261.70÷200=$51.3085 in its present condition. But the present height is to the completed height as 8.5 to 14. The cost per running foot of the completed height will be $84.46.

The interior of the masonry-faced portion is all of Portland cement concrete. It contains 1,364.78 cubic yards. Its cost is, 1,364.78 × 6.774=$9,245.70, or per running foot, $46.2285.

It is impossible to make any exact comparison between the relative cost of the concrete-faced portion and that faced with stone, because in the latter there are departures from the original design, and the work is not finished.

The departures consist in these:

(1) On account of the lateness of the season Portland cement was substituted, with the approval of the Chief of Engineers, for the natural cement on the inside of the work.

(2) It was intended to construct the interior slope of the parapet with small rubble. During the gale of October 3 and 4 the supply of this stone which I had accumulated while tearing down the breakwater was washed overboard. There being no time to get more, the concrete was built out to the interior slope.

The difference in the price of masonry and concrete is, however, very great. The lake face of the work where the stone is cut gives a cost of $39.638 per cubic yard. The cost of the Portland cement concrete is

$6.774. The cost of the stone facing is therefore 5.85 times that of Portland cement concrete. If it were built of uncut stone the cost would then be 4 times the cost of the concrete.

In the above discussion of the cost of the work I have included only the material and labor. Many of the miscellaneous items could scarcely be proportioned between the concrete and the masonry without a degree of attention and care far in excess of the value of the result.

For example: How separate the value of tools and plant when they were used indiscriminately on each class of work? Or how separate the item of the hire when the tug would be used sometimes for one, then for the other, and again for both? In like manner for nearly every item on the list of miscellaneous expenditures.

Then, too, such expenditures will differ at various localities; whereas the actual labor remains nearly constant.

This report gives only the cost in money. The accompanying time-sheet will enable any one to see exactly what amount of labor will be required to produce a similar result. I regard the cost in hours as of far more importance to the engineer than that in money. If the cost in hours be known the cost in dollars and cents can easily be found at any other point by consulting the labor market at that point; whereas when prices vary no idea of cost can be had if quantities be not given.

Damage done by gales.—Early in the morning of October 3 the wind began to rise, and between 7 and 8 a. m. had reached a velocity of 29 miles an hour. It was at that time breaking over the entire length of sections 6, 7, 8, and 9. The condition of the work then was this: The face of section 6 was for more than half its length 7 feet above water. The revetment wall of the interior slope was about 3 feet high. The faces of the other sections were of various heights but none less than 4 feet. In all cases the concrete was sufficiently high to support the front. The concrete in this case was of natural cement. None of it had been in place more than five days, therefore it lacked the strength to withstand the wash of the waves over it.

The velocity of the wind increased to such an extent that between 9 and 10 a. m. it reached 42 miles. The maximum was reached between 2 and 3 p. m., when it was 46 miles for the hour, with a little spurt from 2 to 2.05 of 60 miles per hour. After that the wind subsided until it reached 20 miles between 10 and 11 p. m. The highest velocity reached on the 4th was 37 miles between 10 and 11 a. m.

The damage done by this gale was great. Almost the whole of the concrete interior of sections 6, 7, 8, and 9 was carried away. In some cases the stone ballast of the cribs was washed out as much as 3 feet. The masonry face of the wall was uninjured, although it must have stood unsupported some 12 or 15 hours. A considerable amount of broken stone and small cut-stone was washed off the breakwater. The quantity can only be guessed at.

On October 23 another gale occurred. Between noon and 1 p. m. the wind was 8 miles an hour. It rose to 18 miles in the next hour and remained nearly stationary until 7 p. m. Thence it rose very steadily, and from 1 to 3 a. m. of the 24th it blew at 57 miles. From this figure it gradually fell off. No special damage was done.

Present condition of the work.—A careful examination of the new work was made on May 18, 1888, all the ice having left the lake. No damage to the concrete or the masonry was to be found. The ice last winter was exceptionally heavy. Three heavy oak piles, which had been driven at the northern lake corner of the work as a sort of fender, and which were secured to the concrete parapet by an inch chain, were

torn out and the chain broken away from both anchoring rings. There is no degradation of the concrete surface perceptible.

Result.—If the experience of one very severe winter can be regarded as a test, I think that there can be no doubt as to the ability of either form of structure to withstand the effects of the weather and ice as found at this point.

Recommendation.—In view of the great economy to be obtained over masonry by the use of concrete facing, I have to recommend that the masonry be abandoned after the present supply of cut-stone now on hand shall be exhausted.

Remarks.—In his annual report for 1882 Colonel McFarland estimates that to rebuild the superstructure of the breakwater with timber filled with stone would cost $60 per running foot. The cross-section that he proposed has 256.2 square feet. The cross-section adopted for the masonry superstructure has 334 square feet, or 1.3 times the area of the first. Multiplying $60 by 1.3, we obtain, as the cost of a timber superstructure having the same cross-section as the masonry, $78. Assuming the life of timber to be fifteen years (letter of the Board of Engineers dated February 2, 1887, to the Chief of Engineers), and its annual deterioration to be proportional to its age, we have, as the value of the annual deterioration per running foot, $5.20. The excess of cost of work done last season per running foot over the timber superstructure is $72.82. The extra cost of the work done last year will be justified at the end of fourteen years. If the work be wholly of concrete the cost per running foot will be less and the excess over timber the sooner justified.

MINOR REPAIRS.

The minor repairs to the breakwater were very heavy.

As mentioned in my last annual report the south parapet suffered most. After opening the deck it was found that for a length of 700 feet every one of the open-built cross-walls had given way under the weight of ice. All the solid walls remained firm. The deck joists for the whole length failed as mentioned last year (Report Chief of Engineers, 1887, Part III, page 2352). The deck presented a series of waves both parallel with and transverse to the face of the structure. The lowest points were over the open-built walls and the highest over the solid cross-walls.

All the places crushed in by the ice during the winter of 1886-'87 were repaired. In many cases a single stick had to be taken out of the face of the wall just at the level of the water. It was difficult work. The timber above and below the one stick was perfectly sound. It would have been very expensive to tear down a height of 12 feet of the face, and equally so to rebuild this height. The following mode of repairing was adopted:

(1) The pocket in rear of the broken stick was emptied of stone, as far as might be necessary, and the stick was cut out from one cross-wall to the next.

(2) A new stick was put in the old one's place, the old drift-bolts having been cut off.

(3) A 12 by 12 inch stick was placed in each face corner of the pocket, so as to cover at least the next stick below and the two sticks next above the new one. A 1½-inch screw-bolt was then passed through each end of the new stick and the two corner posts, these latter being then secured to the cross-walls.

The labor necessary to do a small piece of work like this was great. In the first place, about 27 cubic yards of stone had to be taken out and

out back for each pocket where such work was done. In order to remove the stick it had to be hewed out with an adz, the workman lying on his side on a float.

Damage by gales.—The gale of October 3 and 4, 1887, did serious damage. The deck of the south parapet had been partly laid open in order to repair the damages done by the winter. The storm carried away all of the damaged deck and all of the harbor-wall of the parapet, besides greatly injuring many of the cross-ties and washing out much of the stone ballast.

After the storm went down the materials required to repair the damage were at once purchased under emergency and work of restoration was begun. Two-thirds of the harbor-wall of the parapet had been replaced and many of the emptied pockets refilled when came the storm of October 23 and 24, which tore out all the new and incomplete work save a length of 15 feet. The repairs were completed, however, before December 1.

Cost of repairs.—The minor repairs to the breakwater have cost for the year $17,933.32, distributed as follows:

Materials:		
Drift-bolts and spikes		$1,373.03
Timber		6,036.46
Stone		1,667.16
Total materials		9,076.65
Labor:		
Pile-driving	$189.00	
D	586.33	
B	2,215.64	
S	490.93	
C	1,833.83	
P	42.29	
P*	133.46	
V	9.91	
Total labor		5,501.39
Miscellaneous:		
Boats	1,425.47	
Tug hire	701.45	
Inspection	552.08	
Watchman	266.71	
Tools	185.52	
Supplies	135.82	
Plant	37.77	
Fuel	34.75	
Job printing	7.07	
Advertisement	6.00	
General expenses	1.80	
Telegrams	.84	
Total miscellaneous		3,355.28
Total repairs		17,933.32

IV. SAND CATCH OR PILE-PIER.

Construction.—Begun in 1875; 650 feet finished Two hundred and twenty feet added in 1876. No extension since.

Damages and repairs.—Slight repairs made in 1877 and 1887. Thoroughly overhauled and put in order in 1885.

The accumulation of sand is not appreciably greater on the south side of the pier than on the north side, although the work has stood for twelve years as it is now.

Nothing was done to this part of the work during the past year.

V. BOAT-HOUSE.

Repairs were made to the boat-house during the year to the amount of $29.27 for materials and $2.25 for labor. In the cost of the materials is included $13.75 for a stove.

PROPOSED OPERATIONS.

With the funds remaining on hand it will not be possible to do any work beyond a little patching from time to time. Should a new appropriation become available in the course of the next fiscal year it is proposed to expend it mainly in continuing the reconstruction of the superstructure of the breakwater, abandoning, however, the masonry face and substituting therefor the Portland cement concrete.

Minor repairs will be continued from time to time as they may arise.

Judging by the work of the season of 1887 it will be safe to retain the estimate given in last year's report for the cost of reconstruction, viz, $160 per running foot, so as to cover expenses like those for the office, etc.

The work remaining to be done is the same now as it was then, except that instead of the repairs having covered last season a length of 750 feet they only cover 450, of which 200 are not wholly finished. This leaves 1,460 feet of the breakwater on which the superstructure must be rebuilt before anything else is done. The 1,500 feet south of the north parapet still holds together. This should be rebuilt as soon as the above 1,460 feet is finished. We have thus, in all, 2,960 linear feet of reconstruction to do. At the above estimated figure this will cost $473,600.

For minor repairs $20,000 should be allowed. During the past year $18,000 in round numbers were expended on this class of work.

So much of the breakwater is in a nearly ruined condition that no thought of its extension can be considered until all the unsound parts are put in good order.

It lacks 1,245 feet of its full length. At the rate of $110 per foot it will cost $136,950 to complete it.

The shore-arm of the breakwater is to be 3,300 feet long. Its construction at $100 per foot will cost $330,000. The consideration of this work may be omitted for the time being, or at any rate until the extension of the breakwater shall have been completed.

There will thus be required for the year ending June 30, 1890:

For reconstruction	$473,600
For minor repairs	20,000
For extension	136,950
Total	630,550

OCCUPATION OF THE NORTH PIER BY THE DELAWARE, LACKAWANNA AND WESTERN RAILWAY COMPANY.

This pier is the only one of the Government works permanently occupied by corporations or private parties.

The occupancy of this pier began in 1878 and 1879. In his annual report for 1879 Major McFarland mentions that the Delaware, Lackawanna and Western Railroad Company had taken possession of the north pier, which had been for more than fifty years—since 1826—in possession of the United States.

In October, 1879, the railway company committed its first overt act of disputing with the United States the possession of the pier by un-

'taking to remove from the pier the boat-house used by the Govern-
nt employés.

Major McFarland asked for instructions in case the company refused discontinue their encroachments. The matter was referred to the torney-General, who, on November 7, 1879, wrote to the Secretary of ar as follows:

' the railway company or canal company attempt to meddle with this possession the United States) Major McFarland should oppose such resistance, and so much e as is necessary to retain it.

le does not need the service of special legal counsel, but only to be instructed to l every inch of ground to which the possession of the Government for so long a iod gives it a title, and to be furnished with such force as is necessary to enable to do so.

The company still continuing its interference the Secretary of War, November, 20, 1879, instructed the commanding officer at Fort Por- to send a guard to take possession of and protect the pier.

On November 26, 1879, the railroad company, through its counsel, . Sherman S. Rogers, made application to the Secretary of War to ntinue its work on the pier for certain reasons, of which the first two :

irst. The railroad company claims, and believes it will at the proper time be able atisfy the Government authorities that it is the owner in fee, by regular proper e, of the land on which the pier rests.

econd. That the Government never obtained any title, but about the year 1826 structed its pier, paying no attention to the question of title.

After much correspondence and arrangement of details, all of which given in the Report of the Chief of Engineers for 1880, Part 3, pages 5–2201, the company was allowed to continue its work under the lowing stipulation:

STIPULATION OF DECEMBER 9, 1879.

consideration of the action of the authorities of the United States Government, by ch the Delaware, Lackawanna and Western Railroad Company is permitted to pro- l with the construction of 720 feet of pier on the site of the north pier of Buffalo Har- , it is stipulated and agreed on behalf of said company that the United States shall be l to be in possession of the new pier to the same extent as they were of the old pier, that such permission shall not in any manner prejudice any legal or equitable right he United States of America; that the rights of said the United States of America he new pier shall be precisely the same as its rights in the old pier; and that no it whatever of said the United States of America shall be prejudiced by anything e or left undone by it before the completion of such new pier by said company. And l company further agrees to furnish on said pier (or on its premises contiguous, at h convenient place as the Government authorities may suggest) suitable conveni- es for boat landing, and boat-house for the use of the Government officers and men shall be engaged in the construction of Buffalo Breakwater and other improve- its of Buffalo Harbor.

othing herein shall be construed as a waiver of or shall in any manner impair right of said company in the old pier or the premises covered thereby.

witness whereof the Delaware, Lackawanna and Western Railroad Company has sed this stipulation to be signed by its president and its corporate seal to be affixed eto, at its office in the city of New York, this 9th day of December, 1879.

SAM. SLOAN,
President.

ttest:
EAL.] FRED. F. CHAMBERS,
Secretary.

n House Ex. Doc. No. 259, Forty-eighth Congress, second session, otain Maguire shows very clearly that the Delaware, Lackawanna and stern Railroad Company has absolutely no title to the ground under pier. The following is a summary of his investigation:

1) By an agreement dated December 16, 1786, between the commis- ners of the Commonwealth of Massachusetts and of the State of New

York, Massachusetts obtained the title to the soil under the water at what is now known as Buffalo Harbor.

(2) In 1788 Massachusetts sold all her land in New York to Phelps and Gorham for $1,000,000. They, not being able to pay, were released, and on March 8, 1791, Massachusetts sold to Robert Morris the pre-emption right and all other rights which the Commonwealth of Massachusetts had in and to certain lands "together with the right of pre-emption which the Commonwealth hath to all islands or waters in Lake Erie by virtue of any cession from the State of New York to said Commonwealth."

(3) On December 24, 1792, Robert Morris sold to Herman Le Roy and John L. Lincklaen land described as follows:

Beginning at a point on the southern shore of Lake Ontario, 1 mile due east from the northern termination of the strait which divides Lake Ontario from Lake Erie, being a corner of lands resurved by the State of New York, and from said point extending along the shore of Lake Ontario eastwardly, so far as upon actual mensuration shall be found necessary to include within the lines and bounds hereinafter mentioned and described the full and just quantity of 1,000,000 acres of land exclusive of lands covered with the waters of ponds or lakes within the same, which shall be more than 4 miles in circumference, as to such pond or lake, and from the termination of the said boundary so to be ascertained, extending by a meridian line due south to the boundary of the State of Pennsylvania, thence by the same west to a corner of a triangular piece of land granted by the United States to the State of Pennsylvania; thence by the perpendicular line of said triangle due north to the shore of Lake Erie; thence along the shore of Lake Erie to the place where the lines of lands reserved by the State of New York shall be found to intersect the said shore; thence along the lines and bounds of the said reserved lands, northwardly and eastwardly, to the point of beginning.

In the above deed the tract sold extends only to the shore of Lake Erie; the soil under the waters of the lake was not sold.

The Holland Land Company obtained possession, on the fourth transfer, of the land near the mouth of Buffalo Creek on July 10, 1798, and, a little later, of the land at the mouth of the creek. In all the successive transfers the deeds read "to the shore of Lake Erie" as in the deed of Morris to Le Roy and Lincklaen, and make no mention of the soil under the water.

In 1819 the State of New York granted $12,000 to construct a pier at the mouth of Buffalo Creek. This pier was built in 1820–'21. In 1826 the first appropriation for Buffalo Harbor was made by the General Government, which then, through its agents, entered on and took possession of the pier. The appropriation by the United States was made May 26, 1826.

On December 10, 1827, about a year and a half after the United States had taken posession, the Holland Land Company conveyed to John C. Lord, by quit-claim deed," all the land covered and occupied by the United States pier lately erected on the north side of Buffalo Creek and harbor, in the village of Buffalo, etc."

After a series of transfers, all based on this quit-claim deed given by a party which has neither right nor title to the land conveyed, the Delaware, Lackawanna and Western Railroad Company obtained, on February 24, 1868, the land under the pier, and on the strength of such a title claims "that it is the owner in fee by regular, proper title to the land on which the pier rests."

On October 23, 1884, the railroad company again began working on the north pier. Captain Maguire called on the agent of the company to

cause the work to be stopped immediately, and inform this office of the nature and extent of the work which you (the agent of the company) desire to do. Should it be approved by me, I will forward it to the Secretary of War for his approval. But until such approval be received by you I must insist, and shall insist, that you cease operations on the outer end of the pier.

The agent replied that certain necessary work of repair only was contemplated. His letter was referred to the Secretary of War, who granted the authority required.

Work has been suspended while awaiting the action of the Secretary of War, the company thus tacitly admitting the necessity of the Secretary's sanction.

Early in January, 1885, the company again began work. Against its continuance Captain Maguire protested strongly, but the company disregarded his protest and continued the work. Captain Maguire telegraphed the state of affairs to the Chief of Engineers on January 23. On the same day the Secretary of War instructed the commanding officer at Fort Porter to send a guard to protect the pier. On the morning of January 24 the guard was placed on the pier. Mr. John George Milburn, one of the attorneys of the company, gave his word that no further work would be attempted until Captain Maguire received notice from the Secretary of War authorizing it to go on. Under this promise the guard was withdrawn. The company's attorney, Mr. Franklin D. Locke, disregarded Mr. Milburn's promise and notified Captain Maguire that work would be rebegun. On Captain Maguire's representation of the case the Secretary of War ordered the guard to be renewed and continued until further instructions from the War Department.

On February 14, 1885, the matter was again temporarily settled and a supplement was made to the stipulation of December 9, 1879.

Supplement made this 14th day of February, 1885, to a stipulation between the United States of America and the Delaware, Lackawanna and Western Railroad Company, dated the 9th day of December, 1879.

The Delaware, Lackawanna and Western Railroad Company (hereinafter called "The Company") is proposing to build five additional coal pockets on the southeasterly portion of the premises known as the north pier and on the adjacent premises, and to alter the trestles thereon so far as is necessary for that purpose.

The United States opposes the construction of such coal pockets and the alteration of the trestles. This controversy is now settled and arranged as follows:

The United States withdraws its opposition to the construction of such additional coal pockets and such alterations of the trestles upon the company agreeing to comply with the following conditions:

(1) The company will submit to the United States plans of the proposed additions and alterations, and will construct them in accordance with such plans as approved by the Department.

(2) For the accommodation and convenience of the officers and men engaged in the service of the United States, it will build upon the property of the United States, on the south side of Buffalo Creek, at such a location as may be designated by the United States engineer in charge, a boat-house and a boat-landing similar to those now existing, and which were furnished by the company under the stipulation of December 9, 1879. The new boat-house and boat-landing shall not differ materially in its dimensions, nature, and cost from the existing boat-house and boat-landing built under the stipulation of December 9, 1879, as aforesaid. Upon the completion of the new boat-house and boat-landing the company shall have the right to remove the said existing boat-house and boat-landing, and their further use shall then be discontinued and abandoned.

The intention is that the new boat-house and boat-landing is to be accepted by the United States as a substitute for the existing boat-house and boat-landing built for the United States by the Delaware, Lackawanna and Western Railroad Company.

(3) The company is to provide and maintain on the Buffalo Creek, at the southeasterly end of the premises originally known as the north pier, a landing stairway leading from the surface of the dock to the water, of not less than 6 feet in width, and to ascend from the water at an easy and proper angle to the surface of the dock, and to be built substantially in accordance with the plan to be submitted as hereinbefore provided.

(4) The company is to permit the officers and men in the service of the United States, and other persons having business with them, to have access to such landing-stairs over its tracks and property lying in the rear thereof, and it is to keep open for that purpose a passage-way across the same 8 feet in width.

(5) The company is to keep the water-front at such landing-stairs free from obstruction by vessels loading or unloading at its docks, so far as may be practicable and consistent with the necessary and usual requirements of the maritime uses of that portion of the Buffalo Harbor and River, and it is to promote the convenience of the officers and men in the service of the United States in the use of such landing-stairs, and in the access to the same so far as is practicable, having in view the reasonable requirements of the business of the company carried on upon the adjacent property and the uses to which it is put.

(6) The company, before engaging in any further new construction on the premises known as the north pier, will give two months' notice of its intention to do so to the War Department, accompanying its notice with the plan of the proposed new work; but this provision is not to be construed as a concession by either the United States or the company of any rights or interests in the premises on the part of the other.

(7) This stipulation and the agreements and conditions it contains are not to affect in any manner whatever the rights or interests of the United States or the company in the premises known as the north pier, and are not to be taken as a concession by either party that the other party has any such rights or interest, or as a waiver of any such rights or interests.

(8) This supplementary stipulation to go into effect when signed by the president of the Delaware, Lackawanna and Western Railroad Company, sealed with the corporate seal of said company, and approved by the Secretary of War.

In witness whereof the said Delaware, Lackawanna and Western Railroad Company hath caused these presents to be signed by its president, and its corporate seal to be hereunto attached.

Attested by its secretary this the 14th day of February, A. D. 1885, by authority of the board of managers of said company.

The DELAWARE, LACKAWANNA AND WESTERN RAILROAD COMPANY,
[SEAL.] By SAM. SLOAN,
President.

Attest:

FRED. D. CHAMBERS,
Secretary.

Approved by the Secretary of War, and by his direction the seal of the War Department is hereunto attached this 19th day of February, A. D. 1885.

[SEAL.] ROBERT T. LINCOLN,
Secretary of War.

I desire especially to invite attention to the paragraphs numbered 2 and 6 in this supplement.

In No. 2 the company agrees to furnish a new boat-house and boat-landing on the south side of Buffalo Creek. This boat-house and landing has never been built, although the company has not hesitated about doing what it required as allowed by the supplement.

In violation of paragraph 6 the company began early in February, 1888, the work of constructing new coal pockets on the pier. I immediately wrote to Mr. McWilliams, the company's agent, the following letter:

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., February 7, 1888.

MY DEAR SIR: I understand that you have the intention of constructing additional coal pockets on the north pier at the mouth of Buffalo Creek. Will you please inform me by what or by whose authority this is to be done?

In this connection I desire to call your attention to the supplement, made February 14, 1885, to a stipulation made between the United States of America and the Delaware, Lackawanna and Western Railroad Company, dated the 9th day of December, 1879.

Article 6 of this supplement requires notice of 60 days (two months) from the company to the War Department, and a plan showing the new work. I have no knowledge of any compliance having been made with either condition.

You will please let me know so soon as possible what the intentions of the company are.

Very respectfully,

F. A. MAHAN,
Captain, Engineers.

Mr. J. H. MCWILLIAMS,
Agent D., L. & W. Ry., City.

Work continuing, on February 8 this telegram was sent:

BUFFALO, N. Y., *February* 8, 1888.

Delaware, Lackawanna and Western Railway have begun building additional coal pockets in violation agreements of December 9, 1879, and February 14, 1885. Notified agent here that agreement was violated, and asked by whose authority. Notice served yesterday. Agent out of town. Acting agent promises to suspend work until his return. Please send instructions.

MAHAN.

CHIEF OF ENGINEERS.

On February 11 Mr. McWilliams came to my office and told me that he had entirely forgotten the paragraph in the supplement of February 14, 1885, requiring 60 days' notice before beginning new work, and that the work would be discontinued. Instead of carrying out his agreement work was continued, and the following letter was sent to him:

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., February 13, 1888.

SIR: I find that so far from carrying out your promise of last Saturday your men are still at work on the new pockets, the mortises to receive the uprights of the new trestles having been cut in the sills already laid.

I should like to know what this means.

Very respectfully,

F. A. MAHAN,
Captain, Engineers.

Mr. J. H. MCWILLIAMS,
Agent D., L. & W. Ry., City.

The following telegrams were also sent, the first in the morning, the second in the afternoon:

BUFFALO, N. Y., *February* 13, 1888.

Delaware, Lackawanna and Western Railway are continuing work on pier in spite of promises of both agent and attorney that nothing more should be done. Sills were laid for new pockets before my last dispatch. Mortises have since been cut to receive uprights, some of which, 40 feet long, are all ready to be put up. Company seems determined to put new pockets up whether or no.

MAHAN,
Engineer.

The CHIEF OF ENGINEERS.

BUFFALO, N. Y., *February* 13, 1888.

Delaware and Lackawanna continues framing and has moved timbers into convenient position for raising new work. Promises are utterly disregarded. District attorney says it may be a week or ten days before injunction papers can be had. Company seems determined to do work by hook or crook. Would suggest propriety of guard to prevent invasion of Government rights until legal papers can be obtained.

MAHAN,
Engineer.

The CHIEF OF ENGINEERS.

On the same day I received these two telegrams:

WASHINGTON, D. C., *February* 13, 1888.

Telegram of 8th in reference to trespass upon pier at Buffalo by Lackawanna and Western Railway submitted to Secretary of War on 9th instant, recommending the Attorney-General be requested to instruct by telegram proper district attorney to take immediate action, conferring with you.

POST,
Engineers.

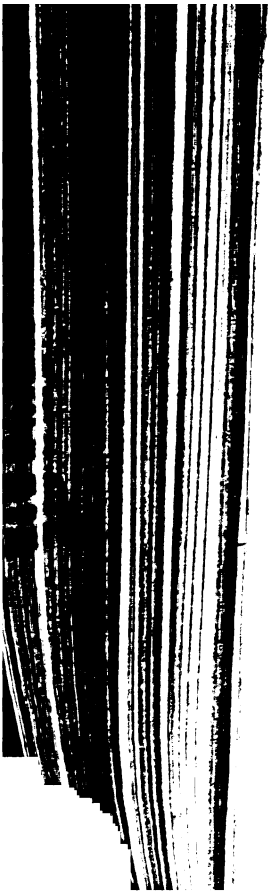
Capt. MAHAN,
Engineers.

WASHINGTON, D. C., *February* 13, 1888.

Attorney-General, February 10, informs Secretary of War that instructions have been sent by telegraph to United States attorney, respecting north pier, Buffalo Harbor.

POST,
Engineers.

Captain MAHAN,
Engineers



If vessels coming from the west with their cargoes of grain and timber—the staple imports—could be quickly discharged and obtain prompt dispatch, the value of the port would be greatly enhanced. Under existing circumstances this can not be. The vessels latterly built are so large that they can not turn around in the creek. They are, as a rule, more than 275 feet long, some even 350 feet. The facilities for discharging and taking cargo are inadequate. The addition of the Blackwell or City Ship Canal relieves the stress to a certain extent. This work was begun in 1848, and has since been twice extended. The lake-front of the city is as yet wholly unavailable. This arises from two causes:

(1) Of the entire length of the lake-front, 3¼ miles, only 1¼ miles is covered by the breakwater.

(2) The portion of the lake-front covered by the breakwater is only partly protected. The breakwater is 6,355 feet long. A length of 1,000 feet in one place and of 1,468 feet in another has a parapet of which the top is 12 feet above water. Of the remainder of the structure the highest part is only 7.60 feet high. During the gale of October 14, 1886, the lake surface reached the level of 7.30 feet above mean stage. Frame buildings standing on ground level with the top of the sea-wall, 14 feet above the ordinary level of the lake, were upset and many of them completely wrecked by the force of the waves. Last October (1887) the water in Buffalo Creek rose twice above 5½ feet, each time during a storm. In 1844, a level of 10 feet above mean stage was noted. It is manifest that under existing conditions the lake-front can not be used for commercial purposes, nor will it be safe for such use until the entire length of the breakwater is at least 12 feet high.

Until this increase in height is obtained no one will risk allowing a vessel to lie at a pier along the lake-front.

During the past twenty-one years the appropriations for this harbor have averaged $67,623. For the past eight years the average is $64,687.50 a year.

At this rate it will be long before the breakwater can have anything added to its length. All the timber-work above water is exposed to rapid deterioration, and much of it will have to be replaced before any further extension can be made.

The grain trade of Buffalo shows an increase of nearly 10 per cent. for the year ending December 31, 1887, over that of the preceding year. The imports of lumber and timber have fallen off. The exports of coal by lake have increased more than 20 per cent. The coal sent out went to sixty-two different ports. It varied in amount from 740,560 tons sent to Chicago to 28 tons sent to Chippewa, Canada.

Accompanying this report were some tables showing the amount of the lake trade of Buffalo and the proportion of the grain delivered in New York by various routes. By bearing in mind the fact that all the grain delivered by canal starts from Buffalo, some idea may be formed of the great number of vessels that have to be handled in the narrow space which forms the present harbor.

Five separate sheets accompany this report, viz:

Sheet A Showing a cross-section of the sheeting adopted for the concrete superstructure.

Sheet B. Showing in detail various assemblages of this sheeting.

Sheet C. Showing the position of the repairs made to the breakwater during the year ending June 30, 1888.

Sheet D. velocities attained by the gales of October, 1887.

Sheet E. Showing the cost in time and money of all classes of labor employed at Buffalo Harbor from July 1, 1887, to June 30, 1888.

Statement of appropriations and allotments made for improving harbor at Buffalo, N. from May 26, 1826, to the present time.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 26, 1826	$15,000.00	$15,000.00	April 10, 1869	†89,100.00	$635,4[illegible]
May 19, 1828	34,206.00	49,206.00	July 10, 1870	80,000.00	715,4[illegible]
April 23, 1830	15,488.00	64,694.00	March 3, 1871	100,000.00	815,4[illegible]
March 2, 1831	12,900.00	77,594.00	June 10, 1872	‡98,485.04	913,[illegible]
July 3, 1832	10,300.00	87,894.00	March 3, 1873	75,000.00	78[illegible]
March 2, 1833	31,700.00	119,594.00	February 23, 1874	20,000.00	1,008,[illegible]
June 28, 1834	20,000.00	139,594.00	June 23, 1874	75,000.00	1,083,[illegible]
July 7, 1838	*68,500.00	208,094.00	March 3, 1875	100,000.00	1,183,[illegible]
June 11, 1844	40,000.00	248,094.00	August 4, 1877	85,000.00	1,268,[illegible]
August 30, 1852	14,000.00	262,094.00	June 18, 1878	80,000.00	1,348,[illegible]
March 3, 1853	349.05	262,443.05	March 3, 1879	100,000.00	1,448,[illegible]
March 2, 1855	452.32	262,895.37	June 14, 1880	90,000.00	1,538,[illegible]
June 28, 1864	†15,000.00	277,895.37	March 3, 1881	90,000.00	1,628,[illegible]
July 2, 1864	37,500.00	315,395.37	August 2, 1882	125,000.00	1,753,[illegible]
June 23, 1866	131,000.00	446,395.37	July 5, 1884	100,000.00	1,853,[illegible]
March 2, 1867	100,000.00	546,395.37	August 5, 1886	112,500.00	1,96[illegible]

* Two appropriations.
†Allotment from general bill.
‡ Includes $23,485.04 which had reverted to the Treasury and was re-appropriated.

The total amount appropriated and allotted for this harbor to Ju 30, 1888, $1,966,480.41, of which $1,958,424.84 has been spent, exclusi of outstanding liabilities.

The amount expended on the present project from its adoption in 18 to June 30, 1888, is $985,344.42, which includes all sums spent for mai tenance and repairs as well as for new work.

Money statement.

July 1, 1887, amount available		$86,960.[illegible]
Amount refunded by contractors on account of overpayment		325.[illegible]
		87,286.[illegible]
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$79,230.47	
July 1, 1888, outstanding liabilities	1,495.89	
		80,726.3[illegible]
July 1, 1888, balance available		6,559.6[illegible]
Amount appropriated by act of August 11, 1888		225,000.0[illegible]
Amount available for fiscal year ending June 30, 1889		231,559.6[illegible]
Amount (estimated) required for completion of existing project		892,500.0[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1890		600,000.0[illegible]

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Buffalo Harbor, New York, is situated within the collection district of Buffalo Creek, New York.

The harbor is lighted by—

(1) A fixed white light, known as the Buffalo Light. It stands 125 yards from the outer end of the south pier at the entrance to Buffalo Creek. It is of the third order. It is 65 feet above the level of the lake, and is visible at a distance of 14¼ miles. It is in latitude 42° 52′ 40″ north, and longitude 78° 53′ 24″ west.

(2) A fixed red light, known as the Buffalo Breakwater Light. It stands on a crib at the north end, and on the land side of the main arm of the Buffalo Breakwater. It is of the fourth order, 37 feet above the level of the lake, and visible at a distance of 12¼ miles. It is in latitude 42° 52′ (39″) north, and longitude 78° 53′ 56″ west.

60 miles per
50
40
30
20
10
0 miles
Noon October 23d 18

60 miles per
50

(3) A fixed white light varied with a white flash every ninety seconds, known as the Horseshoe Reef Light. It stands on Horseshoe Reef at the entrance to Niagara River. It is of the fourth order, 43 feet above the level of the lake, and visible at a distance of 12¾ miles. It is in latitude 42° 52′ 53″ north, and longitude 78° 54′ 56″ west.

Fort Porter is within the city limits on Niagara River.

TABLE I.—*Grain receipts by lake for the years ending December* 31, 1883, 1884, 1885, 1886, *and* 1887.

Articles.	1883.	1884.	1885.	1886.	1887.
Wheat ..... bushels..	24, 105, 420	32, 469, 710	27, 130, 400	41, 430, 440	48, 111, 180
Corn ..... do ..	34, 975, 040	18, 538, 340	21, 028, 230	29, 155, 370	30, 199, 490
Oats ..... do....	3, 226, 900	3, 174, 730	767, 580	1, 014, 670	4, 656, 280
Barley ..... do....	583, 890	534, 130	577, 250	787, 730	1, 459, 420
Rye ..... do....	2, 830, 830	2, 247, 060	309, 370	126, 630	304, 510
Flour (as grain) ..... do....	10, 357, 850	13, 077, 550	14, 516, 400	22, 910, 950	20, 006, 800
Total.....	76, 079, 930	70, 041, 520	64, 329, 230	95, 425, 790	104, 730, 710
Flour ..... barrels..	2, 071, 570	2, 615, 510	2, 903, 280	4, 582, 190	4, 001, 360

TABLE II.—*Lumber receipts by lake for the years ending December* 31, 1883, 1884, 1885, 1886, *and* 1887.

Heading ..... barrels..	9, 500	.....	65, 000	75, 000	.....
Hoops ..... number..	863, 000	350, 000	550, 000	424, 000	47, 200
Lumber ..... feet..	233, 433, 000	231, 653, 000	240, 637, 000	279, 493, 000	264, 612, 000
Lath ..... pieces..	14, 508, 000	13, 099, 000	18, 185, 000	12, 166, 500	12, 469, 000
Railroad ties ..... number..	275, 920	100, 000	87, 500	54, 780	93, 080
Staves ..... do....	2, 362, 100	1, 119, 560	2, 028, 130	1, 289, 500	1, 980, 350
Stave-bolts ..... cords..	14, 820	6, 948	9, 889	9, 710	6, 450
Shingles ..... number..	37, 302, 000	37, 616, 000	52, 716, 000	58, 582, 000	36, 705, 000
Shooks ..... bundles..	.....	84, 690	3, 200	.....	.....
Posts ..... number..	25, 300	60, 000	300, 000	255, 000	7, 000
Logs ..... feet..	.....	28, 000, 000	35, 000, 000	13, 650, 000	31, 500, 000

TABLE III.—*Receipts of other articles by lake for the years ending December* 31, 1883, 1884, 1885, 1886, *and* 1887.

Coal ..... tons..	4, 550	830	520	500	.....
Copper ..... packages..	8, 732	6, 114	1, 385	835	.....
Copper ..... tons..	12, 942	17, 530	19, 198	24, 968	831, 611
Copper ..... cakes and bars..	20, 240	5, 700	1, 140	35, 663	6, 000
Flaxseed ..... bushels..	1, 463, 880	1, 047, 830	2, 858, 260	3, 056, 010	2, 342, 660
Feed ..... sacks..	201, 460	160, 760	205, 390	386, 570	404, 790
Iron ore ..... tons..	45, 855	8, 760	7, 160	28, 430	30, 760
Iron, pig ..... do....	9, 480	7, 850	12, 716	15, 510	19, 780
Lead ..... pigs..	376, 290	121, 500	76, 530	106, 740	195, 590
Lard ..... packages..	72, 330	32, 350	53, 780	193, 810	103, 750
Oil-cake ..... do....	112, 370	113, 050	124, 430	230, 230	106, 520
Pork ..... barrels..	11, 500	4, 450	7, 150	31, 550	26, 960
Seeds ..... bags..	98, 810	70, 586	40, 740	71, 690	22, 700

TABLE IV.—*Principal exports by lake for the years ending December* 31, 1883, 1884, 1885, 1886, *and* 1887.

Coal ..... tons..	1, 253, 940	1, 365, 410	1, 506, 000	1, 562, 050	1, 904, 060
Cement and plaster .. barrels..	212, 960	203, 600	268, 690	378, 940	413, 890
Salt ..... do....	92, 120	63, 320	108, 490	126, 040	109, 120
Salt ..... tons..	11, 435	7, 483	5, 057	2, 635	8, 945
Railroad iron ..... do....	57, 660	25, 953	6, 493	45, 894	40, 528

TABLE V.—*Amounts of grain delivered in New York City by various routes during the year ending December* 31, 1887.

Routes.	Bushels of grain by each route.	Per cent. by each route.
Canal	46, 011, 000	36.09
New York Central and Hudson River Railroad	24, 979, 930	19.59
New York, Lake Erie and Western Railroad	20, 599, 767	16.16
New York, West Shore and Buffalo Railroad	12, 043, 503	9.45
Pennsylvania Railroad	9, 850, 927	7.73
Delaware, Lackawanna and Western Railroad	5, 315, 937	4.17
River and coastwise	1, 414, 708	1.10
All other routes	7, 285, 022	5.71
Total	127, 500, 794	100.00

Arrivals and departures of vessels for the year ending December 31, 1887.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steamers, freight	1, 571	1, 757, 283	274	21, 397	1, 554	1, 741, 397	69	16, 349
Barges	.....	.....	467	62, 595	.....	.....	468	61, 591
Sailing vessels	1, 428	623, 068	113	17, 786	1, 468	650, 778	115	18, 487
Total	2, 999	2, 380, 351	854	101, 778	3, 122	2, 392, 175	652	96, 427

L L 4.

IMPROVEMENT OF NIAGARA RIVER, NEW YORK.

No work was done during the year. Available funds will be held for such further improvement of the channel as may be practicable.

An allotment of $900 was made from the river and harbor act of August 5, 1886, for a survey of this river from Lake Erie to Tonawanda Harbor. This survey was made, and the resulting project for improvement and estimate of cost were submitted on December 29, 1887.

Money statement.

July 1, 1887, amount available	$587.52
July 1, 1888, available	587.52

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1887.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tonnage.	Number	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steam barges	367	115, 866	56	15, 533	319	101, 721	38	10, 183
Towed barges	665	243, 014	41	14, 830	704	257, 319	52	15, 932
Total	1, 032	358, 880	97	30, 363	1, 023	359, 040	90	26, 115

Amount of revenue collected during year ending December 31, 1887 ..... $49, 441.79
Value of imports same year 409, 893.00
Greatest draught of vessels, 14 feet.

L L 5.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

Object.—To obtain a 12-foot channel from Twelve-mile Creek to Lake Ontario.

Project.—The first project for this harbor was submitted in 1846. No action was taken on it.

The second project, submitted in 1873, was to extend piers to the 12-foot curve in Lake Ontario; to dredge a channel 12 feet deep between the piers and 100 feet wide from the shore end of the piers to the deep water of the creek.

Present works.—The present works are the east and west piers. They are the prolongations of piers built by a private company in 1846. The table below shows the work done at this harbor from time to time. The column "year" indicates the fiscal year ending June 30:

Year.	West pier.		East pier.		Channel.		Remarks.
	Extended.	Completed length.	Extended.	Completed length.	Depth.	Width.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1846..	400	400	400	400	7	25	One foot of water on bar. Piers built and channel 25 feet wide, 7 feet deep, dredged by private company.
1852..	.....	.....	.....	.....	.....	.....	Survey made and project submitted, but no action taken.
1868..	.....	.....	.....	.....	.....	.....	Harbor mentioned in connection with ship-canal. Estimate then to lengthen then existing private piers and to do some dredging, $50,000.
1873..	.....	.....	.....	.....	.....	.....	Survey made. Project approved to extend piers to 12-foot curve in lake, to dredge channel 14 feet deep and 12 feet wide between piers and 100 feet wide to deep water in Twelve-mile Creek.
1875..	.....	369	.....	383	.....	.....	Work begun on project of 1873. These are the old private piers.
1876..	60	429	30	413	12	100	Channel dredged 800 feet long.
1877..	.....	.....	.....	.....	.....	.....	West pier breached near inner end during fall of 1876. Channel entirely closed by gravel and sand washed in.
1878..	.....	.....	.....	.....	.....	.....	Breach closed by sinking new cribs on old work. Bar across mouth of creek removed by dredging.
1879..	.....	.....	.....	.....	8	.....	Superstructure of east pier wholly rebuilt.
1881..	.....	.....	.....	.....	4	.....	
1882..	302	731	213	626	11	.....	7,296 cubic yards of material dredged. Mattress protection put down to protect shore end of west pier.
1883..	90	821	.....	.....	7½	.....	Channel closed by two bars. Passage 70 feet wide and 7½ feet deep along west pier; 3,473 cubic yards material dredged.
1884..	30	851	120	746	.....	.....	30 feet of east pier within shore-line much decayed. Shore-line eroded and breach is threatened.
1886..	.....	.....	.....	.....	8	.....	Threatened breach at east pier becoming dangerous. Channel narrow, with only 8 feet of water. Still less depth in harbor.
1887..	.....	.....	.....	.....	.....	.....	Contracts made for materials to rebuild piers.
1888..	.....	831	.....	820	7½	.....	Minor repairs to piers; 80 feet of east pier rebuilt.

OPERATIONS.

The operations for the past year have consisted of the reconstruction of 80 feet in length of the middle of the east pier and in minor repairs of both piers.

On account of the failure of the timber contractor to furnish material authority was asked for and granted to purchase it in open market. No additional expense was incurred by this. Part of the work was done in September and part in November, 1887. All work was by day's labor.

COST OF THE WORK.

The cost of the work was as follows:

Materials:		
Timber		$673.41
Iron		77.36
Stone		306.94
Total		1,057.71
Labor:		
Removing timber in old work	$30.13	
Removing stone in old work	12.46	
Unloading, transporting, and handling timber until it reaches the work	1.75	
Framing and placing timber in position	327.00	
Placing iron in work, this to include labor boring holes for spikes and bolts and driving them	11.75	
Handling stone	52.75	
Miscellaneous jobbing	7.08	
		442.92
Total		1,500.63

By direction of the Chief of Engineers a project for protecting the shore near the east pier, in order to prevent the making of a breach behind the end of the pier, was submitted January 11, 1888, and approved January 17, 1888.

Proposals were invited by advertisement of April 25, 1888. Contracts were made with A. N. Dwight, of Wilson, N. Y., for the timber at $24.70 per thousand feet, board measure, and for the stone at $1.04 per cubic yard; and D. Mc Naughton, of Buffalo, N.Y., for drift-bolts at $2.85 per pound, for screw-bolts at 55 cents each, and for spikes at $4.65 per keg.

PROPOSED OPERATIONS.

The delivery of the above-mentioned materials is to begin July 1, 1888.

It is proposed to devote the funds on hand to the protection mentioned.

Should another appropriation become available during the year it is proposed to expend it in the reconstruction of a part of the west pier.

REMARKS.

The harbor of Wilson is of almost no commercial value. During the past two years three sailing vessels have entered the port and four have cleared. It is situated at the mouth of Twelve-mile Creek, 12 miles east of the Niagara River.

Name of harbor, Wilson, N. Y. Collection district, Niagara, N. Y. Nearest work of defense, Fort Niagara, N. Y. Nearest light-house, Olcott, N. Y.

Money statement.

July 1, 1887, amount available		$8,283.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$702.19	
July 1, 1888, outstanding liabilities	481.10	
July 1, 1888, amount covered by existing contracts	3,900.00	
		5,083.29
July 1, 1888, balance available		3,200.54
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		8,200.54

Amount (estimated) required for completion of existing project.....	$45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing timber, iron, and stone at Wilson Harbor, New York, opened at 12 m., eastern standard time, May 9, 1888, at United States Engineer Office, Buffalo, N. Y., under advertisement of Captain F. A. Mahan, Corps of Engineers, U. S. A., dated April 25, 1888.

No.	Name and address of bidder.	White pine timber (134,768 feet, B. M.).		Drift bolts (1,980), 13,185 pounds.		Screw bolts (108).		Spikes (7 kegs).		Stone, 500 cubic yards.	
		Per M. feet.	Total.	Per pound.	Total.	Per unit.	Total.	Per keg.	Total.	Per yard.	Total.
				Cts.		Cts.					
1	Miles S. Vosburgh, Wilson, N. Y.	.....	.....	.....	.....	.....	.....	.....	.....	$1.10	$594.00
2	John Geal, jr., Buffalo, N. Y.....	.....	.....	.....	.....	.....	.....	.....	.....	2.50	1,350.00
*3	Albert N. Dwight, Wilson, N. Y.	$24.70	$3,328.77	.....	.....	.....	.....	.....	.....	1.04	561.60
†4	Daniel McNaughton, Buffalo, N. Y.....	.....	.....	2.85	$375.77	55	$59.40	$4.65	$32.55	.....	.....
5	Joseph Jackson, Tonawanda, N. Y.....	26.00	3,503.97	.....	.....	.....	.....	.....	.....	.....	.....

* The lowest bidder for timber and stone subject to approval of the Chief of Engineers.
† The only bid for iron.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1887. Arrivals from home ports, none; from foreign ports, 2 sailing vessels; tonnage, 94 tons. Departures to home ports, none; to foreign ports, 2 sailing vessels; tonnage, 94 tons. Greatest draught of vessels, 6 feet.

Amount of revenue collected during year ending December 31, 1887, $75.62. Value of imports same year, $609; value of exports same year, none.

L L 6.

IMPROVEMENT OF OLCOTT HARBOR, NEW YORK.

Object.—To obtain a 12-foot channel from Eighteen-mile Creek to Lake Ontario.

Project.—The first project for this work was submitted in 1846. Nothing was done on it.

The present project, adopted in 1867, is to provide a channel 12 feet deep and 150 feet wide between two parallel piers.

Present works.—The table below shows the work done from time to time at this harbor. The column "Year" means the fiscal year ending June 30.

Year.	West pier.		East pier.		Channel.		Remarks.
	Extended.	Completed length.	Extended.	Completed length.	Depth.	Width.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1846..	.....	.....	.....	.....	.....	.....	First survey made. Project submitted but no action taken.
1866..	.....	.....	.....	.....	½–1½	.....	Second survey made. Bar across Eighteen-mile Creek an obstruction to entering. Project submitted for piers, to extend from 12-foot curve in creek to 12-foot curve in lake; channel to be 150 feet wide between the piers and 200 feet wide from the shore end of the piers to the bridge.
1867..	.....	.....	.....	.....	2½	.....	First appropriation. Nothing done.
1868..	100	.....	.....	.....	.....	.....	Old pier rebuilt, which pier is not stated in report. 1,500 cubic yards of sand dredged.
1869..	.....	275	60	.....	.....	.....	Extension of west pier not stated; 70 feet of cribs without superstructure. No superstructure on east pier. Dredging done, but amounts not given.
1870..	100	516	.....	436	.....	.....	East pier lacks 72 feet of superstructure at north end. Piers are 20 feet wide, except 305½ feet in length of shore end of west pier, which is only 15, and stands 4 to 4½ feet above water. Cribs are 30 feet long, divided into 6 compartments, fastened together with drift and screw bolts.
1871..	180	690	150	588	.....	.....	West pier lacks 100 feet of superstructure. East pier lacks 69 feet of superstructure.
1872..	90	791	149	731	.....	.....	
1873..	90	881	120	851	.....	.....	
1874..	.....	.....	.....	.....	.....	60	Channel is very irregular; 60 feet wide between the piers, 10 feet deep, except for length of 320 feet near shore and, where only 7 to 9 could be had on account of rock. From piers to bridge channel is 650 feet long, 20 to 30 feet wide, 12 feet deep. Piers reach 10-foot curve in lake.
1875..	.....	.....	.....	.....	.....	.....	4,630 cubic yards (scow measurement) of rock removed from channel. Cost $1.98 per yard.
1876..	.....	.....	.....	.....	12	115	5,050 cubic yards of rock removed; cost $1.10. 23,000 yards of sand, mud, clay, etc., dredged, at 14 cents per yard.
1881..	.....	.....	.....	.....	7½	.....	Nothing done since 1876. Channel has shoaled 4½ feet.
1882..	305	.....	.....	.....	.....	.....	This length rebuilt from south end. Shore-arm 90 feet long, 10 feet wide, built to protect beach. Channel not deepened.
1887..	.....	.....	.....	.....	.....	.....	Contracts for materials to repair piers.
1888..	368	881	371	851	7½	190	Piers rebuilt for these lengths from north end.

OPERATIONS.

The operations of the past year were confined to the reconstruction of the northern ends of the piers. The west pier was rebuilt from the water-surface, or as much below as necessary to remove defective timber, for a length of 368 feet from the north end. The east pier was rebuilt in the same way for a length of 371 feet from the north end.

On account of the failure of the contractor to supply the timber required for the work, authority was asked and granted to purchase in open market. The extra cost of this purchase was $87.92. It was paid by the contractor. The work was completed on January 7, 1888. All work was done by day's labor.

COST OF THE WORK.

The cost of the work was as follows:

Materials:	
Timber	$4,133.20
Iron	365.46
Stone	340.52
Total for materials	4,839.18
Tools	42.61
Supplies	1.94

Labor:		
Removing timber in old work	$222.13	
Removing stone in old work	200.89	
Labor, unloading, transporting, and handling timber until it reaches the work	95.30	
Framing and placing timber in position	1,055.82	
Labor placing iron in work, this to include labor, boring holes for bolts, and spikes and driving them	92.36	
Labor handling stone	92.82	
Labor inspecting materials	11.40	
Miscellaneous jobbing	16.30	
Total labor		$1,787.02
Total labor and materials		6,670.75

PROPOSED OPERATIONS.

The funds now on hand will not be sufficient to carry on any work during the coming season.

Should a new appropriation be made for the work it is proposed to expend it on such minor repairs as may be required and in deepening the channel between and inside of the piers.

REMARKS.

This harbor is at the mouth of Eighteen-mile Creek. It is of very small importance for commercial purposes and nearly valueless as a harbor of refuge. It is only 18 miles east of the Niagara River. The fact that, while there is a channel in the harbor 7½ feet deep, the greatest draught of vessels entering during the past season was only 4 feet, shows of itself the important character of the place.

To make the harbor available as a refuge would require the removal of many thousands of yards of materials that now obstruct the creek a little way inside of the piers.

Name of harbor, Olcott, N. Y. Collection district, Niagara, N. Y. Nearest work of defense, Fort Niagara, N. Y. Nearest light-house, Olcott, N. Y.

The Olcott Light is on the outer end of the west pier at the entrance to Olcott Harbor, mouth of Eighteen-mile Creek. It is a fixed white light of the sixth order, 32 feet above the level of the lake and visible from a distance of 11½ miles. Its position is latitude 43° 20′ 27″ N., and longitude 78° 43′ 18″ W.

Money statement.

July 1, 1887, amount available	$5,086.30
Refunded by contractor on account of extra cost of timber purchased in open market	303.28
	5,389.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,597,24
July 1, 1888, balance available	2,792.34
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	7,792.34
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1887: Arrivals from home ports, sailing vessel, 17 tons; from foreign ports, 17 sailing vessels, 205 tons. Departures to home ports, none; to foreign ports, 18 sailing vessels, 212 tons. Greatest draught of vessels, 4 feet.

Amount of revenue collected during year ending December 31, 1887, $2.63. Value of of imports same year, $114.50; value of exports same year, $1,919.

L L 7.

IMPROVEMENT OF OAK ORCHARD HARBOR, NEW YORK.

Object.—To furnish a protected channel 200 feet wide and 12 feet deep from deep water in Lake Ontario to deep water in Oak Orchard Creek.

Project.—The original project for this improvement, adopted in 1836, consisted in contracting the mouth of the creek to 200 feet by two breakwaters running from the shore, one on each side, and a channel between two parallel piers from the 12-foot curve in the creek to the same curve in the lake.

This project, except as to the breakwaters, is still in force.

Present works.—The table below shows the work done from time to time at this harbor. Beginning with 1868 the column "year" means the fiscal year ending with June 30 of the date given:

Year.	West pier.		East pier.		Channel.		Remarks.
	Extended.	Total length.	Extended.	Total length.	Depth.	Width.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1836	.....	.....	.....	.....	.....	.....	Original survey of Oak Orchard Creek. Channel 120 feet wide for 2 miles inland, 12 to 20 feet deep. Mouth closed by bar on which was 2 to 4 feet of water; 650 linear feet of west breakwater built.
1837	.....	.....	.....	.....	.....	.....	East breakwater begun.
1838	.....	300	.....	300	.....	.....	Current failed to open channel. Effect not expected until piers were 1,160 feet long.
1842	.....	.....	.....	.....	7	.....	Harbor available for vessels drawing 7 feet.
1844	210	510	425	725	.....	.....	
1845	.....	.....	.....	.....	5	.....	Gales filled channel 1 foot, leaving 4 feet depth.
1853	290	800	.....	.....	.....	.....	West pier rebuilt and extended.
1857	.....	.....	.....	.....	8	.....	11,000 cubic yards dredged from channel. Inhabitants raised $1,000 to help carry on the work. Piers require rebuilding. Extension to 15-foot curve recommended.
1868	.....	.....	.....	.....	.....	.....	Contracts made for work.
1869	.....	.....	300	300	.....	.....	Old piers in ruins before now. Some work had evidently been done on west pier; when or what does not appear.
1870	150	836	314	614	.....	.....	Piers are 20 feet wide. Cribs are 30 feet long; contain 6 compartments; have grillage bottoms. Dredging 40,650 cubic yards from channel, at 29 cents.
1871	180	1,016	150	764	.....	.....	150 feet of superstructure renewed near middle of each pier.
1872	120	1,134	150	915	.....	.....	7,656 cubic yards dredged.
1873	.....	.....	.....	.....	.....	.....	8,319 cubic yards dredged; 90 feet of superstructure replaced; where or how lost not stated.
1874	.....	.....	.....	.....	.....	.....	3,503 cubic yards of rock and 1,958 cubic yards of mud, sand, etc., taken from channel.
1875	180	.....	.....	.....	.....	.....	Leveled up after settlement of 1 to 3 feet due to gales. Rock excavation, 5,970.47 cubic yards, at $1.36, measured in scows. Rock excavation 4,990.95 cubic yards, at $1.10, measured in scows. Stiff clay and cemented gravel, 1,995.37 cubic yards, at 70 cents, measured in scows. Stiff clay and cemented gravel, 4,489.13 cubic yards, at 60 cents, measured in scows. Mud, sand and gravel, 1,387.81 cubic yards, at 20 cents, measured in scows. Mud, sand, and gravel, 2,149.12 cubic yards, at 99¼ cents, measured in scows.
1876	.....	.....	.....	.....	12	.....	290 cubic yards sandstone removed.
1877	.....	.....	.....	.....	.....	.....	Breach made at shore end of east pier; 800 to 1,000 cubic yards of sand and gravel washed into channel.
1878	*210	.....	†90	.....	.....	.....	* Deck plank removed, pier leveled up, and deck replaced. † To close breach.
1879	.....	.....	.....	.....	.....	.....	Small breach made by vessel in head of west pier repaired.
1882	180	.....	.....	.....	.....	.....	Extension made at shore and perpendicular to line of pier; 69 feet of west pier rebuilt.
1885	1,072	.....	.....	.....	.....	.....	Length rebuilt, distance measured from north end.
1886	.....	.....	.....	.....	.....	.....	Breach made at shore end of east pier by gale of April 6.
1887	.....	.....	.....	.....	.....	.....	Contracts made for material.
1888	.....	1,142	911	911	12	.....	Superstructure of east pier rebuilt.

ɜ piers are now in thoroughly good condition.

CHANNEL.

ɜ channel has a depth of 12 feet for almost its full width. It is ;ht and easy of access. Before the improvement was begun the ı was only 2 to 4 feet.

OPERATIONS.

ɜ operations of the past year were confined wholly to the recon- tion of the east pier, which was torn down throughout the entire h to the water surface and as much below as was necessary to ve all defective timber.

ɜ contractor for furnishing the timber fell so far behind in his work authority was asked and granted to purchase this material in open et. The timber thus bought came and the work was completed in November, 1887. All work was done by day's labor.

ɜ contractor made good the increased cost, $215.36, of the timber ht in open market.

COST OF WORK.

ɜ cost of the work was as follows:

ials:		
imber	$6,024.59	
on	565.18	
one	719.64	
Total for materials		$7,309.41
ies		29.84
		70.68
ɜmoving timber in old work	232.92	
ɜmoving stone in old work	206.93	
ıbor unloading, transporting, and handling timber until it reaches the work	334.35	
:aming and placing timber in position	1,600.35	
ıbor unloading, transporting, and handling iron until it reaches the work	3.38	
ıbor placing iron in work, this to include labor boring holes for bolts and spikes and driving them	115.89	
ıbor, handling stone	164.12	
ıbor, inspecting materials	34.33	
iscellaneous jobbing	42.57	
Total labor		2,756.84
Total materials and labor		10,146.77

REMARKS.

ɜ position of this harbor, about midway between Charlotte and nouth of the Niagara River, although nearer the former than the ', the depth of the safe anchorage afforded by Oak Orchard Creek, mbine to cause this spot to be considered as favorable for a har- f refuge for vessels on Lake Ontario. Under existing circumstances arbor can not be used as a refuge for the largest vessels which run ɜ lake. To do this would require the piers to be extended to the ıt curve in the lake and the channel between the piers to be deep- by 3 feet.

ɜ commerce of the port is small.

PROPOSED OPERATIONS.

The funds remaining on hand will not be sufficient to carry on any work during the coming season.

Should there be any new appropriation for the work it is proposed to expend so much of it as may be necessary in building a crib to prevent the formation of a breach at the shore end of the east pier and to dredge out a large quantity of gravel that has been washed into the channel by different gales of the last ten years.

RECOMMENDATION.

If, after completing the work laid out in the proposed operations, there be sufficient money left to do any work, I would recommend its expenditure for the extension of the piers, with a view to their prolongation to the 15-foot curve.

Name of harbor, Oak Orchard; collection district, Genesee, N. Y.; nearest work of defense, Fort Niagara, N. Y.; nearest Light-house, Oak Orchard, N. Y.

The Oak Orchard Light is on the outer end of the west pier at the entrance to Oak Orchard. It is a fixed white light of the fourth order. It stands 31 feet above the level of the lake, and is visible at a distance of 11¼ miles. Its position is latitude 43° 22′ 29″ north, and longitude 78° 11′ 40″ west.

Money statement.

July 1, 1887, amount available	$3,213.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,845.63
July 1, 1888, balance available	1,367.60
Amount appropriated by act of August 11, 1888	6,000.00
Amount available for fiscal year ending June 30, 1889	7,367.60
Amount (estimated) required for completion of existing project	86,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1887: Arrivals from home ports, 1 sailing vessel, 39 tons; from foreign ports, 11 sailing vessels, tonnage, 914 tons. Departures, to home ports, 4 sailing vessels, 267 tons; to foreign ports, 9 sailing vessels, 756 tons. Greatest draught of vessels, 9½ feet.

Amount of revenue collected during year ending December 31, 1887, $1,555.16; value of imports, same year, $12,331; value of exports, same year, none.

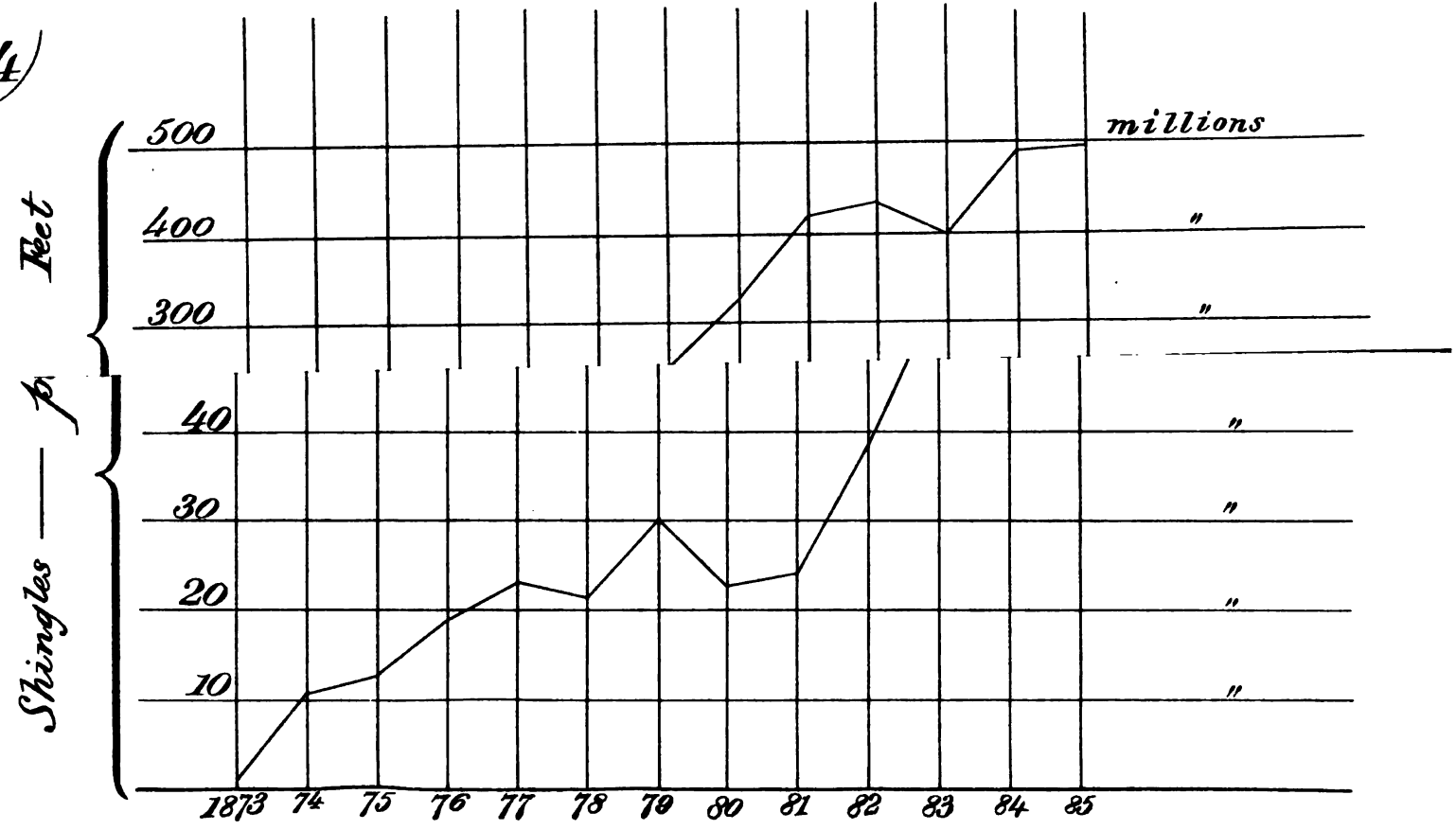
L L 8.

PRELIMINARY EXAMINATION OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK, BETWEEN BLACK ROCK AND TONAWANDA, WITH A VIEW TO A SIXTEEN-FOOT CHANNEL.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., November 17, 1886.

SIR: Referring to your circular letter of September 27, 1886, and the river and harbor act of August 5, 1886, part of which is quoted in the letter, I have to report that at the request of the Hon. John Weber, M. C., I accompanied him to Tonawanda, and there met a number of

4)


Feet
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Eng50 2

PROPOSED OPERATIO

The funds remaining on hand will not be
work during the coming season.

Should there be any new appropriation for
expend so much of it as may be necessary in
the formation of a breach at the shore end of t
out a large quantity of gravel that has been w
different gales of the last ten years.

RECOMMENDATION.

If, after completing the work laid out in
there be sufficient money left to do any worl
expenditure for the extension of the piers, wit
tion to the 15-foot curve.

Name of harbor, Oak Orchard; collection district, G
defense, Fort Niagara, N. Y.; nearest Light-house, Oal
The Oak Orchard Light is on the outer end of the w
Orchard. It is a fixed white light of the fourth order
level of the lake, and is visible at a distance of 11¼
43° 22′ 29″ north, and longitude 78° 11′ 40″ west.

Money statement.

July 1, 1887, amount available .....
July 1, 1888, amount expended during fiscal year, exc
outstanding July 1, 1887 .....

July 1, 1888, balance available .....
Amount appropriated by act of August 11, 1888 .....

Amount available for fiscal year ending June 30, 1889 ..

Amount (estimated) required for completion of exist
Amount that can be profitably expended in fiscal year
Submitted in compliance with requirements of secti
harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS

Arrivals and departures of vessels for the year endin
from home ports, 1 sailing vessel, 39 tons; from foreig
nage, 914 tons. Departures, to home ports, 4 sailing
ports, 9 sailing vessels, 756 tons. Greatest draught of
Amount of revenue collected during year ending
value of imports, same year, $12,331; value of expor

L L 8.

PRELIMINARY EXAMINATION OF TONAWAND
RIVER, NEW YORK, BETWEEN BLACK ROCK
A VIEW TO A SIXTEEN-FOOT CHANNEL.

UNITED STATES E
Buffalo, N.

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river and harbor act of August 5, 1886, part
letter, I have to report that at the request
M. C., I accompanied him to Tonawanda, an

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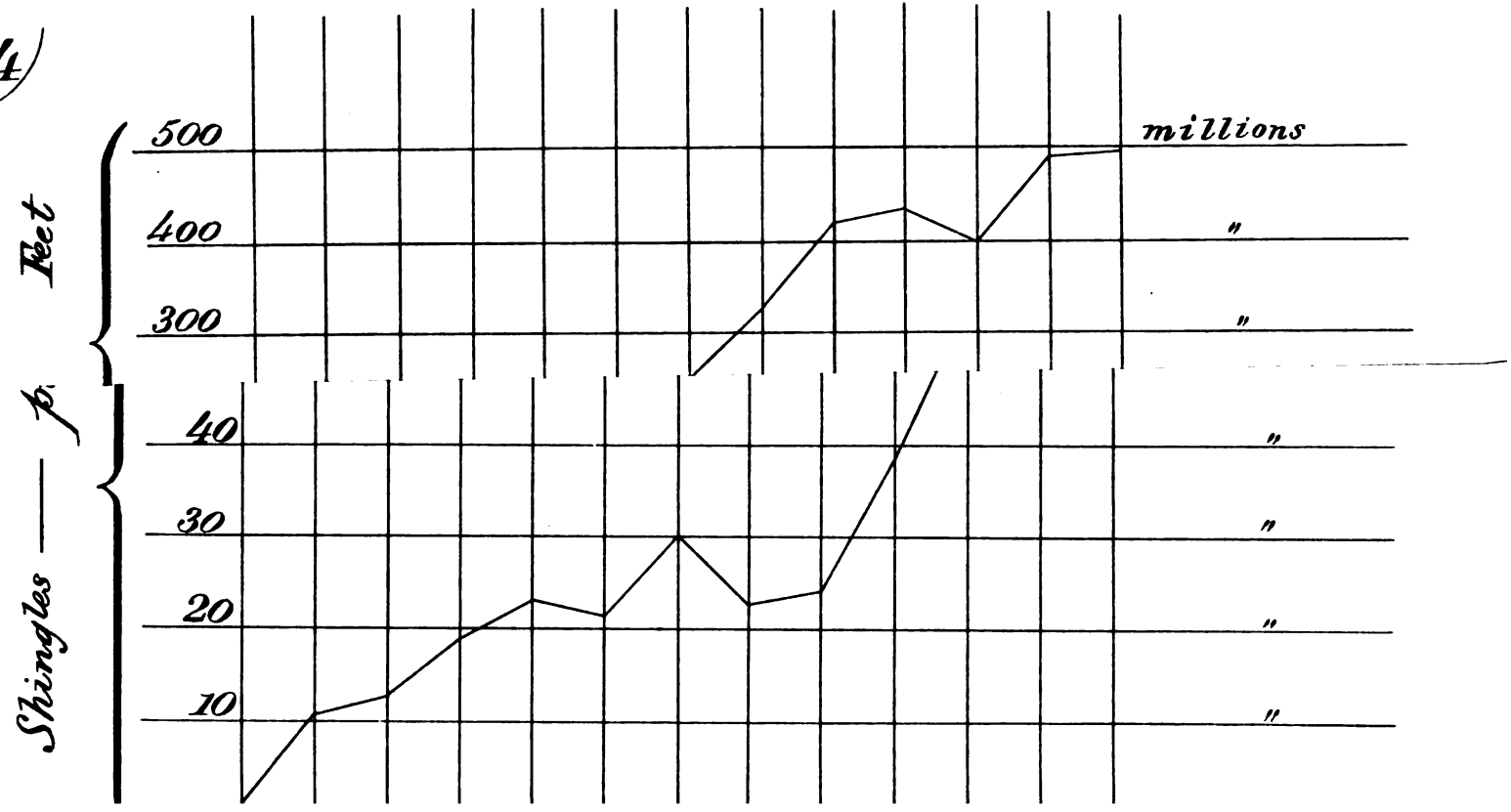


the leading business men of the place. I went with them to make an examination of the harbor, and to see, so far as it was possible, the magnitude of the business interests there collected.

In this connection I would refer to the following documents already on file:

(1) Report of Major McFarland, dated January 17, 1881, with report of Assistant F. T. Hampton, dated November 18, 1880, published in the Report of Chief of Engineers for 1881, Part III.

(2) To indorsement of Major McFarland, dated February 20, 1882, on letter of T. S. Fassett, inclosing printed copy of memorial of Tonawanda Lumber Association to Congress relative to improvement of Niagara River, etc.

(3) To annual report of Major McFarland for the fiscal year ending June 30, 1882.

From these reports I gather that in Major McFarland's opinion the cost of improving the harbor of Tonawanda would be $15,000, and the cost of giving a 16-foot channel from Lake Erie to Tonawanda would be $30,000.

The river and harbor act of August 5, 1886, provides that the "local or detailed engineer shall report to said Chief of Engineers whether in his opinion said harbor or river is worthy of improvement, and shall state in such report fully and particularly the facts and reasons on which he bases such opinion, including the present and prospective demands of commerce." * * *

In accordance with this proviso I give it as my opinion that both the harbor of Tonawanda and the Niagara River are worthy of improvement so as to obtain a 16-foot channel.

I base this opinion on the commercial movement of the port of Tonawanda since 1873.

On the preceding page are the three lines representing the receipts (by lake only) of lumber, laths, and shingles for the thirteen years from 1873 to 1885, both inclusive.

All of this material had to reach Tonawanda by way of the Niagara river.

In 1885 there were received by lake, in addition to the above, about 30,000,000 feet of timber.

The relative amounts of various kinds of wood are not given in the annual report of the Tonawanda Lumber Trade Association. Assuming its value to be only $12 per thousand feet, we have $5,983,356 as the value of the lumber alone received by lake during 1885.

For the present year I have been able, through the courtesy of Mr. T. S. Fassett, of Tonawanda, to obtain the following statistics up to November 12:

Received by lake:		
Lumber	feet	487,538,316
Round logs and timber	do	25,500,000
Shingles	pieces	49,521,000
Laths	do	9,283,000
Posts	do	18,646
Pickets	do	469,400
Of the above there were imported from Canada:		
Lumber	feet	32,534,996
Logs	do	141,000
Pickets	pieces	179,000

on which $56,200.64 of duties were collected.

There have been up to date 1,025 coastwise and 72 foreign clearances. The entries are five less than the clearances.

The total tonnage, domestic and foreign, entered is 379,948 tons.

In addition to the above receipts by lake, there have been received by rail 10,500,000 feet (partly estimated).

The estimated value of receipts is $10,980,000.

I requested when I went to Tonawanda that the number of men and vessels, with the value of the latter, engaged in this trade be sent to me. The information has not yet been received.

It will be seen from the above that the port of Tonawanda is important, especially in the matter of lumber.

The right bank of the river, from some distance above Tonawanda Island to the foot of navigation of the upper part of Niagara River, is a continuous stretch of docks. On the island the banks are beginning to show many signs of occupancy. A railroad bridge across the channel has been begun. In a short time the entire island will probably be one wood-yard. The length of water-front occupied by the docks is estimated at about 5 miles, and is daily receiving additions.

It is my belief that Tonawanda has by no means reached its highest point, and that the present demands of its trade are sufficient to justify the additional depth of water asked.

Very respectfully, your obedient servant,

F. A. MAHAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK, BETWEEN BLACK ROCK AND TONAWANDA, WITH A VIEW TO A SIXTEEN-FOOT CHANNEL.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., December 29, 1887.

SIR: I have to submit the following report of a survey made of the Niagara River between Tonawanda and Black Rock Harbor, New York, in compliance with the river and harbor act of August 5, 1886, together with estimates for making the improvement therein mentioned, viz, to obtain a 16-foot channel.

I understand a 16-foot channel to be one that can be navigated by vessels drawing 16 feet of water.

The limits of the survey are indefinite, as Black Rock lies along the Niagara River for more than a mile, and Tonawanda has a frontage on the same stream of more than 2 miles. I have included the total frontage at both places, so far as the funds at my disposal would permit.

The distance by river between the two places is about 12 miles.

Tonawanda is essentially a lumber port. In the magnitude of this business it ranks next to Chicago. The receipts of timber and lumber during the season of 1887 amount to 556,000,000 feet, board measure. This material is brought from every lumber-shipping point on the Lakes.

The mode of transportation is by steam and tow barges, each steam-barge towing two to five consorts.

The improvement sought is for the benefit of this great trade.

The obstructions to navigation are—

(1) The reef at the entrance to the Niagara River off Black Rock Harbor.

(2) The bar at the head of Strawberry Island.

(3) A few gravel hummocks abreast of the lower end of Rattlesnake Island.

(4) Shoal-water in the channel between Tonawanda and White's Island and the mainland and along the entire river front at Tonawanda.

These obstructions will be considered in order, but before doing so I must call attention to one point, viz, that for a vessel drawing 16 feet there should, in the case under consideration, be a depth of at least 18 feet in the channel in order to have the navigation safe. This is necessary, because in so swift a current as the Niagara River has at many points there must be at least 2 feet of water under the vessel's bottom to enable her to answer her helm promptly.

I will now consider the obstructions and the remedies necessary for each:

(1) *The reef at the entrance to Niagara River.*—This is a mass of rock forming the bed of the Niagara River. Its shape is very irregular. The depth varies from 3 to 18 or more feet. The current is swift, about 10.25 to 11.75 feet per second. Sheet 1* of the tracings show the state of the channel at this point.

The mode of towing requires a wide channel. The consorts are strung out one back of the other behind the towing-barge. The distance of each vessel from the one in front is from 250 to 500 feet. A broad channel is necessary to handle the tow under such conditions. At the present time the tows are broken up at the mouth of the river. The towing-barge, with sometimes one consort in tow (but frequently none at all), goes down the river if she is not drawing more than 12 to a maximum of 13 feet. The remaining consorts are taken in tow by harbor tugs, each tug taking a barge. The limit of draught for the consorts is the same as for the towing-barge.

Bearing the length of the tow in mind (about 2,500 feet, including the vessels and the intervals between them) and the swiftness of the current, it is the opinion of reliable persons interested in the navigation of the Niagara River that the channel should be 400 feet wide. In this opinion I coincide.

The channel I propose is included between the broken lines AA and BB on Sheet 1. As there might be questions of international jurisdiction arising from such work as this I have endeavored to keep all operations on ground which unquestionably belongs to the United States.

The broken line marked "boundary line" is the middle line of the main channel, *i. e.*, the line of greatest depth.

The line AA is drawn as nearly tangent as may be to the 18-foot curve on the Canada shore. The line BB is parallel thereto at a distance of 400 feet. The amount of material to be removed is 41,600 cubic yards, all rock. The estimated cost of taking this out by blasting and dredging will be, according to the best information obtainable from contractors here, $8 per cubic yard, which gives $332,800 as the total cost of clearing out a channel 400 feet wide with a uniform depth of 18 feet.

(2) *Bar at the head of Strawberry Island.*—This bar is wholly composed of gravel. For reasons stated above I have taken 400 feet as a proper width for a channel at this point (Sheet 2*). It is included between the two broken lines. The amount of material to be removed is 164,200 cubic yards. The cost of taking it out at 35 cents a cubic yard will be $57,470.

*Omitted.

(3) *A few gravel hummocks abreast of the* *and* (see Sheet 3*).—These form so slight a be disregarded. Their total volume is 3,6 them at 35 cents per yard would cost $1,26

Shoal water along the river front at Ton material here is all gravel; 423,000 cubic costing, at 35 cents per yard, $148,050.

The total cost of the improvement will t

Channel at Horseshoe Reef	
Channel at head of Strawberry Island	
River front at Tonawanda	
Hummocks at Rattlesnake Island, which may be di	
Contingencies, 10 per cent	
Total cost	

Very respectfully, your obedient ser

The CHIEF OF ENGINEERS, U. S. A.

* Omitted.

APPENDIX M M.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO, EAST OF OAK ORCHARD, NEW YORK.

REPORT OF CAPTAIN CARL F. PALFREY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charlotte Harbor, New York.
2. Pultneyville Harbor, New York.
3. Great Sodus Harbor, New York.
4. Little Sodus Harbor, New York.
5. Oswego Harbor, New York.
6. Sackett's Harbor, New York.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 8, 1888.

SIR: I have the honor to present herewith annual reports of the harbors under my charge.

I have the honor to be, very respectfully, your obedient servant,
CARL F. PALFREY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M M 1.

IMPROVEMENT OF HARBOR AT CHARLOTTE, NEW YORK.

OBJECT.

To secure a navigable channel at the mouth of the Genesee River, on Lake Ontario.

PROJECT.

1829.—To obtain a channel 480 feet wide and 12 feet deep, formed and protected by parallel piers extending to deep water of the lake; executed 1834.

1881.—To secure and maintain, by pier extension and dredging, a channel of navigable width and 15 feet depth of extreme low water. No dredging has heretofore been done, the channel having been formed and kept open by the current of the Genesee River.

PRESENT WORKS.

(1) *West pier*, 3,257 feet long, 20 feet wide, with shore-return 137 feet. Substructure cribs, superstructure of timber-work continuous upon each section, as described below:

Section A, from shoulder of return, at shore-line of 1829, 554 feet, cribs built 1829–1834; superstructure rebuilt 10 feet wide 1869, decayed to ordinary low-water level (2 of gauge). Section B, 564 feet, cribs built 1829–1834; superstructure rebuilt 1885 by Ontario Beach Improvement Company.

(Sections A and B form the water-front of accretion since 1829, owned by New York Central and Hudson River Railroad Company, and leased and occupied by the Ontario Beach Improvement Company. Sections following are in the lake:)

Section C, 1,402 feet, cribs built 1829–1834; superstructure rebuilt 1887–'88. Section D, 235 feet, cribs built 1829–1834; superstructure rebuilt 1864–1872. This section terminates old pier. Section E, 303 feet, cribs and superstructure built 1883–'84. Superstructure carried back over 11 feet of preceding section. This section carries light-house. Section F, 199 feet, cribs and superstructure built 1884–'85.

(2) *East pier*, 2,896 feet long, 20 feet wide, with remains of a former shore connection 402 feet long, of which superstructure has not been renewed since 1834, and which is now entirely under water. Substructure cribs, superstructure timber-work continuous on each section, as below:

Section A, from pile at south end of work now visible, 325 feet, cribs built 1829–1834; superstructure rebuilt 1864–1867, decayed to ordinary low-water level. Section B, 100 feet, cribs built 1829–1834; superstructure rebuilt June, 1887, by U. S. Life-Saving Service. (Sections A and B are the water-front of private land and U. S. Life-Saving Service. The following sections are in the lake:) Section C, 225 feet, cribs built 1829–1834; superstructure rebuilt 1864–1867, decayed to ordinary low-water level. Section D, 797 feet, cribs built 1829–1834; superstructure rebuilt 1886–1887. Section E, 995½ feet, cribs built 1829–1834; superstructure rebuilt 1868–1870. Section F, 303 feet, cribs and superstructure built 1883–'84. Section G, 150½ feet, cribs and superstructure built 1884–'85.

CHANNEL.

Soundings taken May 14, 1888, show 12 feet at extreme low water in a crooked channel having one narrow reach. During the navigation season of 1887 the actual stage of water made navigation possible, though not easy, for vessels drawing 14 feet. At the present stage (2) this draught can be taken in and out of this harbor only in still water and by careful towing.

OPERATIONS.

(1) The rebuilding of superstructure on 1,400 linear feet of west pier section C; cost of material and labor, $9,642.27.

(2) Repair of breach below water in section C, west pier; cost of material and labor, $287.65.

(3) Reballasting one pocket in section F, east pier; cost of labor, $102.10.

(4) Repair of breach below water in section D, west pier, by storms of 1887–'88; cost of material and labor, $9.50.

(5) Removal of 156 sunken piles standing detached from piers, driven 1828–1834; cost of labor and repair of plant, $1,849.90.

(6) Gauge-readings of water-levels, in continuation of work of Lake Survey, have been taken three times daily during the year; cost of labor, $120.

The rebuilding of superstructure was begun October 15, 1887, and ended January 5, 1888. Operations were delayed both by the late high water and by the delay of the contractor in furnishing timber. The late work was difficult and expensive on account of the cold and the accumulation of snow and ice. The additional expense from the delay was fully covered by a rebate on the price of the timber for delay in delivery which was provided in the contract. The breach below water noted above as in this section determined a greater extension of this work than was originally intended, as a breach of the superstructure near the shore-line made it necessary to begin work there, and there was no superstructure sound enough to bond into between the two breaches. As plank could be obtained late in the season and large timbers could not, cross-ties were made of built beams of which the plank are laid flat because of the dovetailing of the tie-head; this is the only particular in which the work has suffered by the delay. These ties are used only in the top course. The extra stone needed for ballasting was taken from decayed portion of the pier well within the present shore-line.

The old guide-piles were solidly driven in sand and mud, and have been silted up more or less since driving. After ineffectual attempts to draw them by leverage and tackle, and by screw-jacks with a trussed beam, two 20-ton hydraulic jacks were used, one on the pier, the other on a scow, with a beam composed of two oak sticks 12 by 12 and 12 by 14 inches, placed to give 26 inches of depth. In this combination, the 12-inch stick showed signs of yielding, and it was re-inforced with one of 10 by 12 inches. The piles yielded very slowly, and seldom started without heavy battering from a floating ram. Of the three sticks used in the straining beam, the 14-inch is shaken to the degree of separating into small sticks; the 12-inch is broken; the 10-inch has been crushed at one bearing.

This work was begun May 8, and continued to the end of the fiscal year.

All operations at this harbor were by purchased material and hired labor.

REMARKS.

At this port since the commencement of work in 1829, the shore-line has advanced against the west pier about 1,100 feet, against the east pier about 700. The land so formed on the west side has been improved and cultivated by the Ontario Beach Improvement Company, who have rebuilt along their river front the superstructure of about 500 feet of the old pier. Of the land formed on the east side, a plat was given to the United States Life-Saving Service for their station, and they have now rebuilt superstructure on their river front, and also protected their lake front against encroachment by waves. The portions of the old pier so occupied, and those inshore therefrom, are no longer essential to the harbor works.

The superstructure of section D of the west pier, from 16 to 24 years old, receives some protection from the former light-house pier built 1880–'81, and also from some piles and another outside work now partly destroyed, which break the force of the waves. Otherwise it could hardly have stood so long. Its timbers are badly decayed.

Section E, west pier, has settled 1 foot along the channel-face for 60 feet.

Section C, east pier, is liable to be breached by a northeast storm. Such a breach, as it is just at the shore-line, would lead to great injury to the channel.

Section E, east pier, is for its outer 200 feet almost a wreck. The repairs of 1870 still hold the remaining portion together.

Section F, east pier, has settled toward channel 1 foot for 100 feet and toward lake 2 feet for 60 feet.

The works thus call for complete renewal of superstructure on 1,455½ feet of pier, and for beveling up one course on 160 feet, two courses on 60 feet.

In the low water of this season the need of dredging is very great. The bed is soft sand and semi-fluid mud. No dredging which does not nearly clear the whole span between the piers is of permanent effect. Unless a channel navigable for vessels having a draught of 14 feet is maintained the commerce of the harbor (which consists largely in the shipment of coal to the upper lakes via the Welland Canal) is crippled. This channel has never been dredged. The Genesee River brings little sediment and has current sufficient to keep its bed clear. The bar near the present shore-line appears to have been formed by the wind-drift of sand over the piers (now nearly checked by the cultivation of the ground by the Ontario Beach Improvement Company) and by the sand swept in at the breach of the west pier in the spring of 1886. The successive charts show this bar swept lakeward and distributed over its channel by the current of the river. It may be reasonably expected that a good channel once dredged between the piers will not require frequent redredging. Dredging of harbor material will also be required outside the piers to secure safe draught of 14 feet.

The harbor of Charlotte has, besides its commercial importance, a great value as a harbor of refuge. The trend of the lake shore to its westward gives it a better shelter from westerly storms than is enjoyed by any other harbor on Lake Ontario, and the resulting ease of access, together with its position midway of the lake-front, have led to its frequent use.

The year 1881, when the present project was adopted, had an exceptionally large tonnage; the commercial statistics presented are therefore to some extent misleading. A full examination of the commercial statistics of ten years past shows a general increase.

ESTIMATES.

For repairs	$20,000
For dredging	25,000
For contingencies, 20 per cent	9,000
Total	54,000

Name of harbor, Charlotte, N. Y.; collection district, Genesee, N. Y.; nearest lighthouse, Genesee, N. Y. (at Charlotte), a fixed red light of the fourth order on crib 300 feet inside of outer end of west pier. Forts Niagara and Ontario, N. Y., are the nearest works of defense.

Money statement.

July 1, 1887, amount available		$20,739.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$15,084.53	
July 1, 1888, outstanding liabilities	901.70	
		15,986.23
July 1, 1888, balance available		4,753.15
Amount appropriated by act of August 11, 1888		45,000.00
Amount available for fiscal year ending June 30, 1889		49,753.15

Amount (estimated) required for completion of existing project	$28,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	28,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under the present project in 1881.

Arrivals and departures.	Number.	Tonnage.
Arrivals	652	149,535
Departures	646	146,181

Imports	$499,798.00
Revenue collected, 1881	80,450.61

Arrivals and departures of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	270	73,522	276	72,474
Sailing vessels	486	104,655	541	127,021
Totals	756	178,177	817	199,495

Revenue from customs for fiscal year ending June 30, 1888	$72,713.54
Value of imports same year	574,289.00
Value of exports same year	702,429.00

Greatest draught of vessels, 14 feet.

M M 2.

IMPROVEMENT OF HARBOR AT PULTNEYVILLE, NEW YORK.

OBJECT.

To furnish a protected channel of navigable width and not less than 10 feet deep at the mouth of Salmon Creek, Wayne County, N. Y.

PROJECT.

The present project provides for a breakwater running easterly from the west shore; a west pier thence northerly into the lake; an east pier parallel to it and 200 feet eastward.

Also a dredged channel between the piers, behind the breakwater, and 400 feet up the creek.

It was proposed in 1884, in order to make dredging of any permanent effect, to build a sand-tight pier parallel to the breakwater and 100 feet southerly from it.

PRESENT WORKS.

(1) *West breakwater*, 330 feet long, 15 and 20 feet wide as below; substructure cribs; superstructure continuous in section as below.

Section A, from shore-line 50 feet, 15 feet wide; built at local expense prior to 1867; superstructure repaired by the United States in 1871. Section B, 180 feet, 20 feet wide, built 1871. This section joins west pier.

(2) *West pier*, 558½ feet long, 20 feet wide; substructure cribs; superstructure continues over all. Section A, 222 feet from shoulder of west breakwater, built in 1874–'75. Section B, 93½ feet, built 1880. Section C, 183 feet, built 1882. Section D, 60 feet, built 1883.

(3) *East pier*, 541½ feet long, 15 to 20 feet wide as below; substructure cribs; superstructure continuous over each section as below.

Section A, beginning 140 feet from shore, 85½ feet, 16 feet wide, built 1880. Section B, 62 feet, 15 feet wide, built 1877. Section C, 30 feet, 20 feet wide, built 1877. Section D, 92 feet, 20 feet wide, built 1873. Section E, 180 feet, 20 feet wide, built 1872. Section F, 122 feet, 20 feet wide, built 1873.

The earliest section of this pier was placed for greatest protection of channel already (1872) dredged; it was extended in both directions. The gap between it and shore was formerly occupied by a wharf, now removed.

CHANNEL.

Has a present depth of about 7 feet at extreme low water between the piers and near the angle of the breakwater, but at the creek mouth the depth is not more than 3 feet.

OPERATIONS.

None.

REMARKS.

This port is now very nearly closed by the bar at the mouth of the creek. With the constant drift of a sandy beach, any work less than that of the full project of 1884 would be shortly obliterated.

The commerce to be benefited is that of a small neighborhood. The port has no rail or canal communication.

Name of harbor, Pultneyville, N. Y. Collection district, Genesee, N. Y. Nearest light-house, Big Sodus, N. Y. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1887, amount available	$2.90
July 1, 1888, balance available	2.90

COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under the present project, in 1870.

Arrivals and departures.	Number	Tonnage.
Arrivals	142	5,500
Departures	142	5,500

Revenue collected, 1870 ..... $1,068 75

Arrivals and departures of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Sailing vessels	25	968	22	552

Revenue from customs for fiscal year ending June 30, 1888 ..... $889
Value of imports same year 6,296
Value of exports same year 655
Greatest draught of vessels, about 8 feet.

M M 3.

IMPROVEMENT OF HARBOR AT GREAT SODUS BAY, NEW YORK.

OBJECT.

To secure a navigable channel from Lake Ontario to Great Sodus Bay, with a depth of 15 feet.

PROJECT.

1828.—To contract the entrance of Great Sodus Bay to 470 feet by breakwaters extending from east and west shores and to define and protect a channel 470 feet wide by piers extending to deep water in Lake Ontario.

1882.—To extend the piers to the 15-foot curve in the lake and dredge the channel between them to 15 feet depth at extreme low water.

PRESENT WORKS.

(1) *West breakwater*, 2,200 feet long, 18 feet wide, built 1829–'34; western, 1,933½ feet covered by beach formed against it; next 207 feet, superstructure 14 feet wide, and 59½ feet, 18 feet wide, rebuilt 1878.

(2) *West pier*, 1,580 feet long, 18 and 20 feet wide, as described below; substructure cribs; superstructure of timber work continuous in each section as below:

Section A, from shoulder of west breakwater, 975 feet, 18 feet wide; cribs built 1829–'34; rebuilt in part 1867–'68; superstructure rebuilt 1877–'80. Section B, 285 feet, 18 feet wide; cribs built 1829–'34; rebuilt 1867–'68; superstructure rebuilt 1867–'68. Section C, 134 feet, 18 feet wide; cribs and superstructure built 1867–'68; leveled up and redecked 1871. This section includes old pier-head 40 feet square. Section D, 185 feet, 20 feet wide; cribs and superstructure built 1883–'84.

(3) *East Breakwater*, 1,651 feet long, 14 and 18 feet wide; substructure of cribs; superstructure of timber-work continuous in sections, as below:

Section A, shore-arm, from Charles Point on the east side of the bay to the lake arm of east breakwater, 215 feet, 14 feet wide, cribs and superstructure built 1884. Section B, 511 feet, 14 feet wide; cribs built 1829–'34; rebuilt 1873–'74; superstructure rebuilt 1887–'88. Section C, 415 feet, 14 feet wide; cribs built 1829–'34, superstructure rebuilt 1887–'88. Section D, 172 feet, 14 feet wide; cribs built 1829–'34; superstructure rebuilt 1870. Section E, 264 feet, 14 feet wide; cribs built 1829–'34;

superstructure rebuilt 1876. Section F, 74
built 1829–'34; superstructure rebuilt 1876.

(4) *East Pier*, 1,294 feet long, 18 and 20 feet
substructure cribs; superstructure of timber
section as below:

Section A, from shoulder of East Breakwat
cribs built 1829–'34; superstructure rebuilt 1
feet, 18 feet wide; cribs built 1834; rebuilt 186
1869. Section C, 154 feet, 20 feet wide; cribs
1883. Section D, 200 feet, 20 feet wide; cribs
1884.

CHANNEL.

Examination made May 18, 1888, showed a
what narrow, channel of 9¾ feet at extreme l
present stage.

OPERATIONS.

(1) Dredging by centrifugal pump; sand
Gain in depth 1¼ feet. Cost per yard as deter
Cost, including inspection, tests, etc., $1,626.4

(2) Sheet-piling along 250 feet of west pier
and filling spaces between cribs by driving o
rial and labor, $1,315.53. (3) Renewal of sup
east breakwater, beginning at the eastern end
toward channel. Cost of material and labor,

On August 4, 1887, an examination by div
portion of the west pier (Sections A B and C)
shore line. The report of this examination, re
pended.

The dredging by centrifugal pump (begun
ber 3, 1887), gave good results, as shown by
pumping into a bin on the pier. As the deli
pier, there was no scow measurement of qua
at the close of this work prevented immediat
and also drove sand in perceptible bars throu
the west pier. The dredging gave a temporar
all that can be obtained by small amounts o
sandy bed of this channel.

The sheet-piling—of 4-inch oak, tightly dri
screws and a wale-piece screw bolted to wall
ber 12, and completed January 3. It will secu
benefit of future dredging, until the beach sh
able advance.

The rebuilding of superstructure on east br
the late high water, and by the delay of the
timber. The later work was somewhat more e
and difficulties arising from the accumulation

An injury to the scow is also attributable to

The work was begun October 12 and relin
cause of the formation, from the freezing spra
feet of ice upon the breakwater. About 140 r
left open, leaving ten days' work for a smal
completion of the 926 feet mentioned above.
at the date of rendering this report. The br

injury from being left unfinished last season. The resumption of operations for so small a piece of work was delayed to await the services of the foreman, who had stored tools and material at the close of the previous season.

The increase of expense of the late work and the repair of the scow will be fully covered by a rebate on the price of timber for delay in delivering, which was provided in the contract.

All operations at this harbor were by purchased material and hired labor.

REMARKS.

The west breakwater, being fully protected by the accretion formed against it, is no longer important to the harbor works.

Of the west pier renewal of superstructure is needed on 419 feet, Sections B and C. Sections C and D are settled out of level, but not to an important degree.

Of the east breakwater, 172 feet, Section D needs renewal of superstructure; Sections E and F, 12 years old, are liable to need extensive repairs, but may still serve some years.

Of the east pier, 940 feet, Sections A and B need renewal of superstructure.

From the records, supplemented by the recollections of an assistant, I gather that dredging was not needed in this channel until the west pier was wrecked (between 1856 and 1868) and the channel filled in by the littoral drift. The dredging which has since been done has never been more than a narrow trench in a broad area of easily moved sand, and has been of little permanent value, as the amount removed has been very small in comparison with that remaining.

Were the whole entrance, 470 feet broad, once dredged to hard bottom, it is probable, as the ends of the piers are on hard bottom, that no more dredging would be required in many years, and that, with the broad entrance and fine roadstead in that bay, a valuable and permanent harbor of refuge would be secured.

Although shipments at this harbor have been hampered by shoal water both in the calendar years 1887 and 1888, the commercial statistics show a gain over last year, notably in the value of exports. Considerable shipments of coal are made to American ports on the upper lakes, and a channel in accordance with the project of 1882 is greatly needed.

At this harbor I have the honor to recommend: (1) Maintenance of existing works; (2) dredging the entire space between the piers to hard bottom; and thereafter a channel 200 feet wide and 15 feet deep at extreme low water.

ESTIMATES.

For repairs	$18,000
For dredging	30,000
For contingencies, 20 per cent	9,500
	57,500

Name of harbor, Great Sodus, N. Y. Collection district, Oswego, N. Y. Nearest light-house, Big Sodus, N. Y.; a fixed white light of the fourth order, varied by a white flash every two minutes, on a bluff three-fifths mile west of entrance to bay. A fixed white light of the sixth order, 180 feet in side of the outer end of west pier, and a fixed red light of the sixth order at elbow of west pier. Nearest work of defense, Fort Ontario, N. Y.

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	24,000

COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under present project in 1881.

Arrivals and departures.	Number.	Tonnag
Arrivals	53	5,
Departures	78	7,

Imports	$20,311
Exports	18,000
Revenue collected, 1881	3,228

Arrivals and departure, of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnag
Steamers	9	1,629	8	1,5
Sailing vessels	112	23,443	126	22,7
Total	121	25,072	134	24,3

Revenue from customs for fiscal year ending June 30, 1888	$17,989
Value of imports same year	158,338
Value of exports same year	183,490

Greatest draught of vessels, 12 feet.

tween cribs ranging from a few inches to 2 feet. The natural bottom here is hard and stony.

2. For the next 500 feet the cribs sunk 1867–1870 rest upon the remains of the old cribs of round timbers, flatted at their beds, built 1829–1834. Their bearing is unequal; for 210 feet they overhang 1 to 3 feet. In much of this reach the planked bottom of the new cribs has given way and a few of the bottom timbers have been started loose; bottom covered with loose stone.

3. For the next 300 feet the new work rests inside the old; the lake-wall of the old cribs slopes from the bottom to the level at which new work begins, or is bulged between those levels. There is much scattered stone; the beach sand begins in this reach.

4. For the remainder the old cribs are collapsed. The cross-ties have so far disappeared that the diver could put the whole length of his arm into the mortise. The lake face of the old work, as far as it can be seen, is fairly vertical. The bottom shows only sand, though it is probable that the advance of the beach has covered stone lost from the old cribs.

It is in this last reach that the greatest leakage of sand has occurred.

The wide spaces between new cribs, in the first reach, can be filled whenever the work of renewal of superstructure uncovers these cribs.

In the next reach the stone in the superstructure shows no marked settling. It would appear that the filling has found a bearing or that there has been some repair by interior work of which the office has no record.

The third reach gives at present no trouble. It appears probable that, with the advance of the shore-line, beach sand will at some future time leak through. To make the lake-face tight would be a work of great difficulty and expense, from the mass of débris to be cleaned away, and it is not improbable that this débris, when once silted up, may prove an effectual sand-check.

It is noteworthy that, at a moderate depth, the water of the lake is still very cold. The diver complained of it, and his appearance indicated much more suffering from cold than during much longer immersions at depths on the average greater in October last year.

I have the honor to be, very respectfully, your obedient servant,

CARL F. PALFREY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M M 4.

IMPROVEMENT OF HARBOR AT LITTLE SODUS BAY, NEW YORK.

OBJECT.

To secure a channel from Lake Ontario into Little Sodus Bay, of navigable width, and depth not less than 15 feet at low water.

PROJECT.

To contract by breakwaters the entrance of the bay to a width of 250 feet and maintain a channel 200 feet wide and 15 feet deep at extreme low-water level, protected by parallel piers.

PRESENT WORKS.

(1) *West breakwater*, from west beach to west pier, 469 feet, 10 feet wide; substructure cribs; superstructure timber-work continuous on sections as described below:

Section A, 379 feet, 10 feet wide; cribs and superstructure built 1870 and 1871 now buried beneath beach. Section B, 90 feet, 10 feet wide; cribs and superstructure built 1871. This section joins inner end of west pier. Section C, 200 feet, 8 feet wide; brush and stake work built in front of eastern portion of breakwater in 1887–'88.

(2) *West pier*, 1,960 feet long, 20 feet wide; substructure cribs; superstructure of timber-work continuous in sections as below:

Section A, 186 feet, 20 feet wide; cribs built in 1854; superstructure gone; substructure sound, just awash at present stage (2.0 of gauge). Section B, 800 feet, 20 feet wide; cribs and superstructure built in 1867–'68 and leveled with new deck in 1870–'71. West breakwater joins this section 40 feet north of its beginning. Section C, 260 feet, 20 feet wide; cribs and superstructure built in 1870–'71. This section includes the pier-head 30 feet square at its outer end. Section D, 242 feet, 20 feet wide; cribs and superstructure built 1881. Section E, 272 feet long, 20 feet wide; cribs and superstructure built 1883. Section F, 200 feet long, 20 feet wide; cribs and superstructure built 1885; repaired and refilled 1887. This section carries the light-house.

(3) *East breakwater*, 1,850 feet long, 20 feet wide; substructure of cribs; superstructure of timber-work continuous over all; connection with shore of brush and stake work as below:

Section A, 170 feet, 8 feet wide; brush and stake shore connection, built 1885. Section B, 150 feet long, 20 feet wide; cribs and superstructure built 1878. Section C, 750 feet long, 20 feet wide; cribs and superstructure built 1875. Section D, 540 feet long, 20 feet wide; cribs and superstructure built in 1874. Section E, 240 feet long, 20 feet wide; cribs and superstructure built in 1873. This section joins the east pier.

East pier, 1,510 feet long, 20 feet wide; substructure cribs; superstructure of timber-work continuous in sections as below:

Section A, 512 feet, 20 feet wide; cribs built in 1872–'73; superstructure rebuilt in 1887. Section B, 635 feet, 20 feet wide; cribs and superstructure built in 1881. Section C, 122 feet, 20 feet wide; cribs and superstructure built in 1882. Section D, 241 feet, 20 feet wide; cribs and superstructure built in 1883.

CHANNEL.

No soundings have been taken during the year. Soundings taken 1881 showed a navigable channel of 12 feet at extreme low water. The bed of this channel has shown little or no change since the extension of the west pier, 1882–1885.

OPERATIONS.

(1) The building of 200 linear feet of stake and fascine shore revetment connecting the west pier with the west beach. Cost of material and labor, $807.27.

(2) The rebuilding of superstructure on 512 feet of east pier, Section A, from its junction with the east breakwater outward. Cost of material and labor, $4,678 or $9.13 per linear foot.

(3) The repair of outer end of west pier by building four interior cribs and refilling outer 20 feet of pier with stone. Cost of material and labor, $267.05.

(4) Minor repair of deck of east breakwater. Cost of material and labor, $94.82.

Operations were begun September 23, 1887, and completed December 23, 1887; the beginning having been delayed by high water and the completion by failure of timber contractor to supply material.

The stake and fascine revetment placed in front of a decayed cribwork as an aid in the formation of a beach which has buried most of the west breakwater has done its work well. Already while in progress the beach was filled in behind it and formed in front of it to such degree that it was carried across a reach which was at the beginning of the work too deep to admit of building this class of work. This dike, being exposed to the full force of the waves, was more heavily staked and ironed than the one forming the shore connection of the east breakwater and paved with large stones set edgewise and settled in place with the mallet. The cost of the work has been about half that of rebuilding timber superstructure on the remains of the old west breakwater, and it is not likely to require removal.

All operations at this harbor were by purchased material and hired labor.

REMARKS.

Complete renewal of superstructure is needed on 1,020 feet of the west pier, seventeen and eighteen years old, being sections A and B outside junction with old west breakwater, and also on 1,530 feet of the east breakwater, thirteen, fourteen, and fifteen years old, being sections "C," "D," and "E."

The pier is exposed to the prevailing storms, and its breach would fill the channel with the sand of the beach.

The breakwater is little exposed to breach except from the somewhat rare northeasters, but is important as protection to vessels lying at the coal trestles. For this purpose it is desirable that the new superstructure have a greater elevation than the present, which can be gained without increase of expense by the parapet form.

The shipments at this harbor during the past season have been in vessels of light draught, plying to Canadian harbors. To enable shippers to utilize the capacity of the Welland Canal, as per present project, would call for a considerable amount of dredging.

The commerce of this port, which has for some time been declining under the influence of railroad competition for all traffic but that of the lake shores, shows a marked revival from local railroads becoming part of the Lehigh Valley system.

The shipments of the past year show decided gain over those of the preceding.

I have the honor to recommend the maintenance of the existing works and channel.

ESTIMATES.

For repairs	$30,000
Contingencies, 20 per cent	6,000
Total	36,000

Money statement.

July 1, 1887, amount available	$14,193.08
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,165.55
July 1, 1888, balance available	7,027.53
Amount appropriated by act of August 11, 1888	16,000.00
Amount available for fiscal year ending June 30, 1889	23,027.53
Amount (estimated) required for completion of existing project	16,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Little Sodus, New York; collection district, Oswego, N. Y.; nearest light-house, Fair Haven, N. Y.; a fixed white light of the fourth order, near the head of the west pier. Nearest work of defense, Fort Ontario, N. Y.

Amount of commerce and navigation when the work of improvement began under the present project, in 1881.

Arrivals and departures.	Number.	Tonnage.
Arrivals	151	17,913
Departures	247	30,058

Imports	$174,004.00
Exports	32,400.00
Revenues collected, 1881	34,223.62

Arrivals and departures of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	27	4,252	30	6,194
Sailing vessels	166	41,586	194	44,530
Total	193	45,838	224	50,724

Revenue from customs during the fiscal year ending June 30, 1888	$2,972.80
Value of imports same year	44,713.00
Value of exports same year	414,147.00

Greatest draught of vessels, 11 feet.

M M 5.

IMPROVEMENT OF HARBOR AT OSWEGO, NEW YORK.

OBJECT.

To provide a basin sufficient for the needs of commerce at the mouth of the Oswego River, New York, and to secure and maintain a navigable channel into said basin and river.

PROJECT.

27.—To inclose by breakwaters a western basin 11 acres outside head line, and an eastern basin 9 acres outside bulkhead line, and rotect the entrance channel by piers (completed 1829); pier ex- led 1869.

70.—To inclose by a breakwater of crib-work filled with stone, a tern basin of 100 acres outside 9-foot curve and existing western kwater. (Completed in 1882.)

82.—To build an eastern breakwater on alignment of western, shelt- g an eastern basin.

83.—To build spurs projecting from lake face of western breakwater the purpose of breaking the accumulated and reflex waves, occa- ed by that breakwater, which have rendered the entrance excep- ally difficult and dangerous during storms.

PRESENT WORKS.

) *Inner west breakwater*, 1,993 feet long, of masonry and crib-work, elow:

ection A, shore-arm, 250 feet masonry, built 1828, in good preserva- . Section B, lake-arm, 110 feet masonry, built 1828–'29, dilapidated. ion C, 248.8 feet crib-work, built 1828–'29, repaired and rebuilt 1844– '60–'67–'74, now ruinous from fire and decay. Section D, 838.2 feet, me description as above, transferred to Light-House Department in . Section E, light-house pier-head of irregular form, extending 92 on line of breakwater, and 132 feet lakeward; crib-work, built 1835, ood repair; transferred to Light-House Department in 1886. Sec- F, crib-work, 432 feet long, 30 feet wide, extending lakeward from ion E, built 1869.

) *Inner east breakwater*, 750 feet crib-work, 30 feet wide, built 1828– repaired 1844; transferred to Gerrit Smith, esq., in 1852.

) *Outer west breakwater*, 6,032 feet long, 35 feet wide; substructure, s; superstructure, timber-work; continuous on sections, as below: ection A, from shore, 846.3 feet; cribs built 1871–'72, superstructure ilt parapet form, 9 feet high, 1887, bonded into that of following sec- s: Section B, outer end of shore-arm, 70 feet; cribs built 1872; super- cture rebuilt parapet form 12 feet high, 1884; upper deck and sup- ing timbers of creosoted Georgia pine. Section C, beginning of -arm of breakwater, from angle eastward 2,910 feet; cribs built –'77 upon natural bottom of the lake. Superstructure, continuous, ilt parapet form, 12 feet high, 1884; upper deck and supporting tim- of creosoted Georgia pine. In this section is the breach of 1884, 140 wide and 475 to 615 feet east from the angle. Section D, continu- n of lake-arm, 570 feet; cribs built 1877–'79, on natural bottom of . Superstructure continuous, 8 feet high, cross-section rectangular, t 1877–'79. Section E, continuation of lake-arm, 900 feet; crib built , on foundation 3 to 6 feet, trench dredged in sand and filled with e. Superstructure (continuous except at end of 1879 work) 8 feet , cross-section rectangular, built 1879–'80. Section F, continuation ke-arm to eastern angle, 490 feet; cribs built 1880–'82, on foundation 10 feet, trench dredged in sand and filled with stone. Superstruct- 12 feet high, parapet form, rebuilt 1884, all of white pine. Section hannel-arm, 246 feet long from south side of lake-arm; cribs built , foundation 4 to 10 feet, trench dredged in sand and filled with stone. erstructure on first 62 feet, parapet form 12 feet high, built 1882; ainder, with rectangular cross-section, 6 feet high, built 1882.

(4) *Detached spur*, 100 feet long, 40 feet wide, 250 feet from entrance, 10 feet from lake face of breakwater, on trenched riprap foundation built in 1885.

(5) *Outer east breakwater*, located on the prolongation of the line of the lake-arm of the outer west breakwater, 351.75 feet eastward from it, consisting of a lake-arm and a channel-arm.

Section A, lake arm, 213 feet long, cribs built 1882; foundation 4 to 10 feet trench dredged in sand to rock and filled with stone; superstructure, parapet form, 12 feet high, continuous, built 1882, all of white pine. Section B, channel-arm, 35 feet from south side of lake-arm southward, crib built 1882, foundation 10 feet trench dredged in sand to rock and filled with stone.

CHANNEL.

A channel 18 feet deep at entrance, shoaling to 15 feet in a little less than 2,000 yards, was dredged in 1884.

OPERATIONS.

(1) Under contract with J. B. Donnelly, signed July 1, and extended on October 31, 1887, renewal of superstructure, in parapet form, 9 feet high, on 846.3 feet of shore-arm. Cost under contract $28,940.22; inspector, $333.33; being for running foot, $34.60.

(2) By purchased material and hired labor, repair of breach, below water, near and west of great breach of 1884. Cost of material and labor, $511.20.

(3) By purchased material and hired labor, repair of wharf-front, United States reservation, at old stone breakwater. Cost of material and labor, $512.40.

(4) By purchased material and hired labor, repair of breach made by steamer *Monteagle* April 26, 1888. Cost of material and labor, $25.89.

(5) By purchased material and hired labor, minor repairs, including submerged breach, section D, and redecking counterforts. Cost of material and labor, $2,089.11.

The work under contract, delayed by the late high water, was begun August 15 and completed November 30. The work in progress was tested by two severe storms, the parapet, framed but not filled or decked, being exposed to the shock of heavy waves. It bore the test well; no timbers were torn out, and only two of the banquette walls displaced to such a degree as to require the use of clamp screws.

The breach mentioned above (2) was in a crib sunk at the close of the season of 1872, injured by storm before superstructure was built over it, and repaired in place; as the cribs in the breach have been torn away by successive storms, its situation has again become an exposed one, and it has again yielded. In the repair of the breach, this crib should be replaced by a new one, unless more thorough repair should be possible, when the shaken parapet superstructure shall have been removed, than under the conditions of this year's work.

The repairs mentioned above (3 and 5) were carried on with a small working party as a means of holding workmen engaged for the other works during the delay caused by the non-delivery of timber.

The breach made by the steamer *Monteagle* was made on a fair day and in still water. It was apparently due solely to careless handling.

REMARKS.

Renewal of superstructure is needed on extension of light-house pier, Section F, inner west breakwater.

The superstructure of sections D and E, outer west breakwater, now eight and nine years old, has been repeatedly injured by storms and repaired, and is much shaken. With frequent repair it may serve two years more without serious breach, but should soon be renewed in the parapet form, continuous with sections C and F.

The riprap foundation of the spur-crib has proved insufficient. The storm of November 19, 1886, carried away that of the northwest corner, producing a settling of about 8 feet, and twisting the crib. The settling of the new stone placed to repair that loss, and of the old under the unequal bearing, now leaves the crib settled uniformly along its western face 8 feet.

This spur-crib, placed 1885, has proved a manifest improvement of the entrance to the harbor by its effect in breaking the accumulated wave sweeping the length of the lake front of the west breakwater. The completion of the project of 1883, by placing at least one more on that face, would materially aid this improvement, and also lessen the shock upon the one now placed and the scour upon its foundation.

A petition has been presented for the removal of the small section of east breakwater now completed, as offering greater hindrance to commerce by the increased difficulty of entrance than aid by the additional shelter afforded. Reports on this subject are printed in the Report of Chief of Engineers for fiscal year 1887.

The commerce of Oswego has shown no regular increase or decrease since 1875, and has varied within narrow limits during that period. That of this year is exceeded by but four years of the past thirteen.

At this harbor I have the honor to recommend: (1) The maintenance of the existing west breakwater as now standing; (2) The removal of the east breakwater; (3) The building of one spur-crib 150 feet in length as per project of 1883.

ESTIMATES.

For repairs	$45,000
For spur	30,000
For removal of east breakwater	15,000
For contingencies, 20 per cent	18,000
Total	108,000

Name of harbor, Oswego, N. Y. Collection district, Oswego, N. Y. Nearest lighthouse, Oswego, N. Y. A fixed white light of the third order at the eastern end of the old west breakwater, a fixed red light of the fourth order on eastern end of outer west breakwater, a fog-bell attached.

Money statement.

July 1, 1887, amount available,	For repairs	$47,737.78	
	Continuing improvements	15,000.00	
			$62,737.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		34,110.72	
July 1, 1888, outstanding liabilities		989.02	
			35,099.74
July 1, 1888, balance available			27,638.04
Amount appropriated by act of August 11, 1888			100,000.00
Amount available for fiscal year ending June 30, 1889			127,638.04

Arrivals and departures of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonn
Steamers	398	74,156	382	73,
Sailing vessels	2,028	369,907	1,984	368,
Totals	2,426	444,063	2,366	441,

Revenue from customs for fiscal year ending June 30, 1888	$570,54
Value of lumber imported same year (149,973,867 feet)	1,884,24
Value of barley imported same year (3,619,555 bushels)	2,983,72
Value of all other imports	230,85
Value of coal exported same year (473,349 gross tons)	2,063,33
Value of all other exports	46,81

Greatest draught of vessels, 12 feet 6 inches.

M M 6.

IMPROVEMENT OF HARBOR AT SACKETT'S HARBOR, N. Y.

OBJECT.

To deepen the harbor within Ship-house Point over an area of ab 15 acres to 12 feet at extreme low water.

This project was adopted in 1881. Previous to 1881 $6,000 was pended in 1826–1828 in deepening the same area.

PRESENT PROJECT.

To limit the excavation to an area of about 6 acres and to define entrance, and provide a mooring place by a crib 18 feet square, pla

OPERATIONS.

None during the fiscal year, the balance of appropriation being insufficient for useful effect.

Money statement.

July 1, 1887, amount available	$72.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11.97
July 1, 1888, balance available	60.14
Amount appropriated by act of August 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,060.14
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	13,000.00

COMMERCIAL STATISTICS.

Name of harbor, Sackett's Harbor N. Y.; collection district, Cape Vincent, N. Y.; nearest light-house, Sackett's Harbor, N. Y. A fixed white light of the fifth order on Horse Island, 1½ miles west of town. Nearest work of defense, Fort Ontario, N. Y.

Amount of commerce and navigation when the work of improvement began under the presen project in 1883.

Arrivals and departures.	Number.	Tonnage.
Arrivals	178	5,668
Departures	177	5,009

Imports	$21,505.00
Exports	9,300.00
Revenue collected, 1883	3,430.56

Arrivals and departures of vessels during the fiscal year ending June 30, 1888.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	61	1,458	62	1,502
Sailing vessels	54	4,249	52	4,065
Total	115	5,707	114	5,567

Revenue from customs for same year	$3,870.65
Value of imports, same year	41,198.04
Value of exports, same year	none.

Greatest draught of vessels, 11½ feet.

APPENDIX N N.

IMPROVEMENT OF OGDENSBURGH HARBOR, ON THE RIVER SAINT LAWRENCE; OF HARBORS ON LAKE CHAMPLAIN; AND OF GRASS AND TICONDEROGA RIVERS, NEW YORK; AND OF OTTER CREEK, VERMONT.

REPORT OF MAJOR MILTON B. ADAMS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

IMPROVEMENTS.

1. Ogdensburgh Harbor, New York.
2. Grass River (at Massena), New York.
3. Breakwater at Rouse's Point, Lake Champlain, New York.
4. Swanton Harbor, Vermont.
5. Breakwater at Gordon's Landing, Lake Champlain, Vermont.
6. Plattsburgh Harbor, New York.
7. Burlington Harbor, Vermont.
8. Otter Creek, Vermont.
9. Ticonderoga River, New York.
10. Narrows at Lake Champlain, New York and Vermont.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., July 10, 1888.

GENERAL: I have the honor to transmit herewith annual report for river and harbor works under my charge during the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

N N 1.

IMPROVEMENT OF OGDENSBURGH HARBOR, NEW YORK.

A project was formed for the improvement of this harbor by a Board of Engineer Officers in 1868, which provided for dredging the channel of the Oswegatchie River below the bridge, deepening the channels along the city front on the St. Lawrence River and across the bar northeast of the light-house, and the construction of a pile-pier to prevent the water of the Oswegatchie speading over the bar or shoal between these channels. The pile work was only recommended in the event of

the water of the Oswegatchie not following the lines of the deepened channels after the dredging had been completed.

The dredging, as provided for in the project, was completed in 1876, and the piling was found unnecessary; consequently, operations were confined to dredging the channels, which were left in good condition.

For a few years following the completion of the project of 1868 there was a suspension of operations. The harbor was ordered resurveyed in 1879, which, being done in 1880, showed considerable shoaling of the channels during these four years of inactivity; and furthermore that the obstructions in the channels were mainly due to saw-dust and other waste products of saw-mills which had been thrown into the Oswegatchie River in violation of local regulations forbidding it. The amount of damage, or shoaling, as shown by the survey of 1880, was 40,000 cubic yards, which it was estimated would cost $12,000 to remove, so as to place the channel in good condition again.

The collector of customs informs me that this practice has ceased, and that the few saw-mills there now use steam power and burn their refuse.

The original project was estimated to cost $175,000, and there had been expended up to 1880, exclusive of $3,000 for a survey in 1852, $107,000, leaving $68,000 still due the general improvement, owing to the piling of the project not being required.

In 1882 it was recommended to place the harbor in condition to admit the largest vessels that will be able to pass the enlarged Welland Canal, at an estimated cost of $76,000, as follows:

Outer bar, 1,500 feet by 400 feet by 3.1 feet, about 80,000 yards, at 30 cents per yard	$24,000
Near Rome, Watertown and Ogdensburgh Railroad wharves, 1,150 feet by 300 feet by 3 feet, 40,000 yards, at 40 cents per yard	16,000
Oswegatchie mouth, 1,000 feet by 300 feet by 1.8 feet, 20,000 yards, at 20 cents per yard	4,000
Channel along city front, 7,200 feet by 150 feet by 4 feet, 160,000 yards, at 20 cents per yard	32,000
Total	76,000

This estimate was intended to provide for a depth of 15 feet in the channels and 16 feet over the outer bar.

Operations have been carried on in accordance with the above scheme of improvement since 1882, and under contracts dated December 13, 1883, August 26, 1884, September 12, 1885, and November 19, 1886. There were 35,345 cubic yards removed under the first contract from the vicinity of the Central Vermont Railroad wharves and from the channel near by, connecting with the St. Lawrence River; 48,194 yards were removed under the second from the channel near the Rome, Watertown and Ogsdenburgh Railroad wharves and that leading therefrom to the St. Lawrence River; 14,988½ yards were removed from the angles in the channels, under the third contract, and under the fourth contract, which was completed August 31, 1887, there were 51,389.37 cubic yards removed, mostly from the channel along the city front, and 52 yards of gravel and 3 large bowlders were removed from near the mouth of the Oswegatchie River. The prices paid under these contracts, owing to the development of harder material in the bottom than the original estimate contemplated, were such that they seemed to indicate that the total figures in the estimate would prove too small, until the fourth contract was made, which was at prices low enough to warrant an expectation that the entire amount of the original estimate may not be exceeded, notwithstanding the obstacles which are now known to exist.

At the close of the present fiscal year 149,916.87 cubic yards of mud, etc., 52 yards of gravel, and three large bowlders have been removed from the channels of this harbor, at a cost of $35,000, consuming the available funds; and about the same amount remains to be removed, mostly in the city front channel, in order to complete the scheme of improvement as per estimate.

There are $40,000 asked for this harbor to be applied to dredging operations.

Money statement.

July 1, 1887, amount available	$6,568.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,568.44
Amount appropriated by act of August 11, 1888	15,000.00
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Ogdensburgh, N. Y.; collection district, Oswegatchie; nearest lighthouse, Ogdensburgh, N. Y.

RECAPITULATION OF THE BUSINESS OF THE DISTRICT OF OSWEGATCHIE FOR THE YEAR 1887.

With the exception of a small percentage, the transactions relate to the business of the port of Ogdensburgh.

Statement of the value of imports and exports, amount of duties and fees collected, and number of vessels entered and cleared during the year 1887.

Item.	Amount.	Item.	Amount.
Value of dutiable imports entered for consumption	$1,147,992.00	Value of imports under consular seal	$1,538,109.00
Value of free imports entered for consumption	749,641.00	Duties on imports under consular seal, estimated	114,967.80
Value of domestic merchandise exported	1,695,930.00	Making total of same	1,653,076.80
Value of imports entered warehouse	3,631.00	Duties collected on imports for consumption	197,540.61
Duties on imports entered warehouse	3,066.42	Duties collected on imports from warehouse	953.49
Making total value of imports entered warehouse	6,697.42	Fees collected	4,281.00
		Total amount collected	202,775.10
Value of imports entered for transportation to other districts and exported	57,794.00	Total value of imports and exports	6,115,096.75
Duties on imports transported to other districts and exported	23,621.58	Estimated value of merchandise from domestic ports	4,200,000.00
Making total value of imports thus entered	81,415.58	Estimated value of merchandise shipped to domestic ports	6,000,000.00
Value of imports entered for transportation to other districts	549,222.00	Total ascertained and estimated value of the commerce of the port	16,315,096.75
Duties on imports entered for transportation to other districts	28,346.85	Number of entries of vessels	1,330
Making total value of same	577,568.85	Number of clearances of vessels	1,296
		Tonnage of vessels entered	281,719
		Tonnage of vessels cleared	280,716

Leading articles of merchandise received from foreign ports and received from and shipped to domestic ports during the year 1887.

Articles.	Quantity.	Articles.	Quantity.
Wheat ..... bushels..	833, 036	Hogs ..... number..	500
Corn ..... do....	2, 964, 629	Butter ..... pounds..	200, 000
Barley ..... do....	573, 554	Cheese ..... boxes..	92, 000
Oats ..... do....	810, 109	Pork ..... barrels..	1, 500
Potatoes ..... do	2, 806	Hides ..... number..	102, 553
Flour ..... barrels..	108, 378	Wool ..... pounds..	140 000
Hay ..... tons..	500	Coal ..... tons..	112. 284
Straw ..... do...	100	Feed ..... do ..	6, 000
Eggs ..... dozen..	1, 603, 130	Kerosene oil ..... barrels..	17, 000
Lumber ..... feet..	52, 140, 069	Dry goods, hardware, sugar, iron ore, and other merchandise arrived from Boston and other cities *via* Ogdensburgh and Lake Champlain Railroad, and shipped to Chicago and other Western cities ..... tons..	54, 100
Laths ..... pieces..	6, 665, 000		
Shingles ..... number..	6, 906, 000		
Sheep ..... do....	52, 893		
Cattle ..... do....	2, 378		
Horses ..... do....	1, 808		

The above was obtained through the kindness of the collector of customs.

N N 2.

IMPROVEMENT OF GRASS RIVER, AT MASSENA, NEW YORK.

There have been no operations under the above head during the past year.

The project for this improvement was adopted in 1881, and appears in the Report of the Chief of Engineers for that year, pages 2457 to 2460. It contemplates the formation of a channel from the St. Lawrence River to Massena Village, a distance of about 7½ miles by water, with a least width of 40 feet and a least depth of 4 feet, at an estimated cost of $12,000.

The items of the estimate are as follows:

Excavation at rapids, 2,000 yards, at $4 per yard	$8,000
Excavation at Haskell's Wharf, 1,500 yards, at $1 per yard	1,500
Excavation at other points 3,000 yards, at 50 cents per yard	1,500
Contingencies, etc	1,000
Total	12,000

Under an appropriation of $3,000 for this work proposals were invited in April, 1883, for the removal of 2,000 cubic yards of obstructing material at rapids, the first item as above, and in response only one bid was received, at the rate of $6 per yard. It was evident, therefore, that it would cost at least $12,000 to make the improvement at that point and that the funds available were only sufficient to remove one-fourth of that single obstruction. As no benefit could arise from the work unless completed, and as the work could be carried on more economically when the improvement of at least one place could be accomplished in one season's operations, an additional appropriation of $9,000 was asked for, and no further action has been taken since.

During the fiscal year some inquiry was made by dredgemen in regard to this work, and they were informed as to its nature, amount, etc., and proposals were solicited from them for undertaking the improvement, but they made no definite offer and nothing has been done.

The balance of the appropriation, after paying the cost of advertising, etc., amounting to $2,948.60, is now to the credit of the improvement.

In case additional funds become available for this work, it is expected to apply them, together with the balance now on hand, in dredging operations according to the original plan.

Money statement.

July 1, 1887, amount available	$2,948.60
July 1, 1888, balance available	2,948.60
Amount (estimated) required for completion of existing project	17,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name, Grass River (Massena), New York. Collection district, Oswegatchie. Nearest light-house, Ogdensburgh, N. Y.

A steam ferry-boat makes regular trips from Cornwall, in Canada, opposite the mouth of Grass River, to a point a mile below Massena, beyond which the obstructions in the channel will not allow the boat to go. The collector of customs was unable to furnish any statement of receipts, and it is presumable that little or nothing was collected.

N N 3.

BREAKWATER AT ROUSE'S POINT, LAKE CHAMPLAIN, NEW YORK.

Operations have been carried on during the year in accordance with the original plan adopted in 1885, and under contracts dated August 22, 1885, and October 28, 1886.

The first contract was made with Richard Fenner Hawkins, of Springfield, Mass., for the construction of 800 linear feet of breakwater adjoining the shore; the other with John L. Johnson, of Fulton, N. Y., for the extension of the 800-foot shore section, 550 feet further into the lake. The last annual report stated that an extension of time for completion of the first contract to September 30, 1887, had been requested and granted, and that it was occasioned by the novel character of the work, in connection with the handling and laying of the large stones on the slopes and crown of the breakwater. This contract was completed and closed within the extension of time that was granted.

Work under the second contract has been progressing fairly well. Most of the rubble-stone required in the foundation of this 550-foot section was placed during the winter of 1887, and has had time for thorough settlement before the large stones are added as a facing and crowning along this portion of the structure.

There were 65 linear feet of this section of the breakwater completed during the fiscal year by the addition of the large crowning and facing stones, and as the second contract does not require completion until November 30, 1888, it is believed it will be finished well within that date, consuming the available funds.

The good effects of this improvement are apparent along the town front and at the docks by the comparative calmness of the water there now during southeasterly storms, which formerly caused considerable commotion.

As funds become available for this work they are to be applied under the approved project, which contemplates the construction of a straight

breakwater of rubble and large stone extending from Stony Point in the general direction of the southern point of the 6-foot curve south of Windmill Point until the 18-foot curve is reached, a total distance of about 2,000 feet. The estimated cost of the breakwater was placed at $110,000. To date there have been two appropriations for this improvement, amounting to $55,000, which has either been consumed or placed under contract.

Money statement.

July 1, 1887, amount available		$23,970.59
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$14,402.21	
July 1, 1888, outstanding liabilities	2,225.11	
July 1, 1888, amount covered by existing contracts	6,965.00	
		23,642.32
July 1, 1888, balance available		328.27
Amount appropriated by act of August 11, 1888		13,500.00
Amount available for fiscal year ending June 30, 1889		13,828.27
Amount (estimated) required for completion of existing project		41,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		41,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Name of harbor, Rouse's Point, N. Y.; collection district, Champlain; nearest lighthouse, Windmill Point.

Number of vessels and tonnage cleared for and entered from foreign ports during the year 1887.

Entered:	
Number of vessels	1,015
Tonnage	98,976
Cleared:	
Number of vessels	1,024
Tonnage	99,042
Value of merchandise exported by vessels during 1887	$850,000

Lumber imported during season of navigation by vessels.

Lumber	feet B. M.	153,035,758
Value		$2,688,328.00
Duties		303,833.95

Value and duties collected on various articles imported by vessels during year 1887.

Value	$152,673.00
Duties collected	24,854.13
Value of free goods imported by vessels during year 1887	50,845,00

The above was obtained through the kindness of the collector of customs.

N N 4.

IMPROVEMENT OF SWANTON HARBOR, VERMONT.

The project was adopted in 1873, and the undertaking was thought to be of doubtful expediency at that time, as shown by the report of the officer then in charge. (See Annual Report Chief of Engineers, 1873,

page 396.) Subsequent events have shown that the doubts as to the propriety of trying to anticipate the wants of the harbor in its improvement, which were expressed in submitting the original report and project, were well grounded.

The appropriations which have been made from time to time have been expended in the construction of a breakwater; the docks and wharves it was designed to protect were never built, however, and the shipping facilities at the harbor now, instead of being located where they would have received some protection from the breakwater, are clustered around two docks three-fourths of a mile from it.

In consideration of the foregoing facts, and the uncertainty attending the location of docks and wharves that were possibly to be built, it has been recommended for some years that no further appropriation be made for this harbor until the future development of the shipping and commercial interests indicate more definitely the direction in which improvement should be made for their protection.

According to the preliminary examination and survey made in October and December, 1884, and reported in January, 1885, it would seem that the conditions for indicating more definitely the direction in which improvement should be made have arrived.

Should the work be undertaken, however, instead of following the exact scheme of that report, I would recommend the building of a breakwater nearly parallel with and about 1,000 feet distant from the shore, from a point 200 feet north of the outer end of the existing structure until a position directly west of the docks is reached, and the extension of the existing structure somewhat nearer the shore; by which means it is thought the increased harbor capacity afforded would justify the change from the plan of the above report, submitted in January, 1885.

Money statement.

July 1, 1887, amount available	$326.93
July 1, 1888, balance available	326.93
Amount (estimated) required for completion of existing project	169,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	80,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Name of harbor, Swanton, Vt.; collection district, Vermont; nearest light-house, Point aux Roches.

Number of steamers arrived and cleared during year 1887		183
Number of sailing vessels arrived and cleared during year 1887		45
Number of unrigged vessels arrived and cleared during year 1887		31
Unladed from the aforesaid vessels:		
Iron	tons	2,125
Coal	do	1,750
Other merchandise	do	8,160
Total	do	12,035

The above was obtained through the kindness of the collector of customs.

N N 5.

BREAKWATER AT GORDON'S LANDING, LAKE CHAMPLAIN, VERMONT.

The project for this improvement was adopted in 1887, and has for its object the construction of a breakwater, composed of rubble and large stones, extending in a straight line from a point some 250 feet south of

the dock or landing, where the water is about 3 feet deep at lowest stage, to a point on the 18-foot curve and about 100 feet north of the line drawn from the dock to Cumberland Head.

At inception the object of the undertaking seems to have been the affording of increased shelter on the west shore of Grand Isle, Lake Champlain, which incidentally has involved the protection of the dock or landing which gives the improvement its name.

An appropriation of $18,750 was made for this work in the act approved August 5, 1886, but the general character of the shore, as indicated on the Coast Survey maps, was about all the information with regard to this locality in my possession when the appropriation was made. Consequently, and as a subsequent step in the order of procedure, it became necessary to make a thorough examination and survey, and to design a structure that would afford the desired shelter.

The examination and survey were made October, 1886, and a map, drawing, report, etc., were prepared which covered the facts in regard to the locality, and, with my recommendations respecting the proposed structure to be built for protection, were submitted January 12, 1887, and having been duly considered by the Board of Engineers, received your approval.

The time consumed in connection with the examination of the plans and specifications for this new work was such that it could not be regularly advertised until June 28, 1887.

In response to the advertisement inviting proposals for the construction of 500 linear feet shore section of this breakwater, five bids were received, ranging in the aggregate from $15,150 to $31,927.88; and a contract was made with the lowest bidder, William James Daly, of Ogdensburgh, N. Y., under date of August 1, 1887, for the above amount of work. Operations were commenced August 11, 1887, and continued until the latter part of November, when a suspension took place until the formation of ice would allow the work to be carried on more economically. Operations were resumed January 26, 1888, and continued into March, at which time there had been a total of 4,711½ yards of rubble-stone placed in the foundation, which brought this pile of loose stone as high as was thought safe when the ice would be going out. Operations could not be again resumed before the close of the fiscal year.

There have been 4,711½ cubic yards of rubble-stone placed in the foundation and core of the structure up to date.

The cost of the undertaking has been placed at $38,158.72.

Money statement.

July 1, 1887, amount available		$18,413.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,192.27	
July 1, 1888, outstanding liabilities	400.01	
July 1, 1888, amount covered by existing contracts	11,149.94	
		16,742.22
July 1, 1888, balance available		1,671.68
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,671.68
Amount (estimated) required for completion of existing project		9,408.72
Amount that can be profitably expended in fiscal year ending June 30, 1890		9,408.72

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Gordon's Landing; collection district, Vermont; nearest lighthouse, Cumberland Head.

The proprietor of the landing states that three-fourths of the business of Grand Isle, Vt., is done there, and that 1,500 tons of freight are probably handled each season. Also that large quantities of produce and fruit, as well as stock, for the markets, pass over the dock at the landing.

N N 6.

IMPROVEMENT OF PLATTSBURGH HARBOR, NEW YORK.

The original project for the improvement of this harbor was adopted probably in 1836, the date of the first appropriation, and proposed the construction of a breakwater about 1,000 feet east of the steam-boat docks.

There were 1,250 linear feet of breakwater constructed between the years 1836 and 1875, at which latter date the last modification of the project was completed.

This modification, made in 1870, provided for an extension of the former structure to the southeast, the dredging of some shoal areas within the breakwater, and the protection of a portion of the adjacent beach by a revetment.

Since 1875 operations have been confined to necessary repairs of the breakwater, and the dredging of limited areas between it and the steamboat docks.

The report of survey at the mouth of Saranac River, Plattsburgh, N. Y., which has appeared as House Ex. Doc. No. 72, Forty-eighth Congress, second session, comprehends the dredging of 110,000 cubic yards there, and would amount to a considerable extension of the limited areas of dredging operations, and therefore may be said to constitute a further modification in the project for this harbor improvement.

The appropriation of $5,000, by act approved August 5, 1886, was pledged under contract dated March 9, 1887, the work comprehended in the contract being the dredging and removal of 25,000 cubic yards from in front of the docks.

Operations commenced about the middle of September, and the contract was completed and closed before the end of November, 1887, practically consuming the appropriation.

As additional funds become available for this harbor, it is expected to apply them in dredging operations, so as to afford sufficient depths for the boats that frequent the harbor, and in making repairs to the breakwater as required.

Money statement.

July 1, 1887, amount available	$4,903.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,426.23
July 1, 1888, balance available	477.42
Amount appropriated by act of August 11, 1888	7,000.00
Amount available for fiscal year ending June 30, 1889	7,477.42
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Plattsburgh, N. Y.; collection district, Champlain; nearest lighthouse, Cumberland Head; two beacon lights at Plattsburgh.

Kind of craft.	Arrivals.		Departures.	
	No. of vessels.	Tons.	No. of vessels.	Tons.
Steam	798	368, 445	798	368, 445
Sail	42	3, 538	42	3, 538
Canal-boats	761	68, 512	761	68, 512
Total	1, 601	440, 495	1, 601	440, 495

Value of goods imported from foreign ports	$1, 536
Value of 7,500 tons of coal imported from domestic ports	30, 000
Value of miscellaneous merchandise imported from domestic ports	27, 000
Total	58, 536

Value of goods shipped from Plattsburgh.

Name of articles.		Amount.	Value.
Iron ore	tons	27, 135	$81, 405
Dressed lumber	feet	5, 775, 000	115, 500
Other merchandise			95, 000
Total			291, 905

The above was received through the kindness of the collector of customs.

N N 7.

IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

The first project for the improvement of this harbor was probably adopted in 1836.

Modifications of the original project have been made from time to time so as to afford adequate protection to the increasing commercial and shipping interests of the harbor.

In 1874 a modification was proposed whereby an extension 2,000 linear feet northward was effected; in 1884 an extension to the south was proposed by the officer then in charge; and again, in 1886, a plan for further extension both to the north and to the south, which outlined their proper locations, covering considerable of the shore in both directions, was considered by the Board of Engineers, and received its authoritative sanction in regard to the distance from shore proposed for the extensions, but the 150 feet openings recommended at the ends of the existing structure, before commencing new work, were not approved.

The rationality of the existing irregular outline in the breakwater, *i. e.*, its want of rectilinearity from end to end, is found in its gradual development by successive extensions under different administrations, and at distant periods of time, when the immediate and prospective wants of the harbor necessarily presented decidedly different phases.

The reason for the last modification, whereby the extension will gradually withdraw the ends of the structure from water 36 and 39 feet deep into water about 30 feet deep, and then prolong it about parallel to the shore and 1,000 feet distant from the outer ends of the docks in shallower water, is that there will be considerable saving in the cost per linear foot of protection afforded by bringing the work nearer shore and adhering to the shallower depths. At the same time it will result in no injurious restriction of the harbor capacity, provided a limit to the extension of docks into the harbor or a commission line is established, which ought to be done, and is looked for, since the attention of the board of trade here has been invited to the subject.

A contract was made for 240 feet extension at the southern end of the breakwater, under date of August 12, 1887, with Luther Whitney, of Keesville, N. Y. Work was commenced August 22, 1887, and there were 2,449.1 cubic yards of rubble-stone placed in the foundation before the close of navigation.

Operations were resumed May 16, and there have been 4,209.2 cubic yards of rubble-stone placed in the foundation at the close of the fiscal year, making it about high enough to receive the cribs. It is expected the framing and sinking of the cribs will soon be undertaken, as the timber for them is arriving, and that this contract will be completed November 30, 1888.

As additional funds become available for this improvement it is expected they will be applied in further extensions to the breakwater, so as to keep pace with the growth of the commerce and the extensions of the line of docks and wharves of the harbor, and in maintenance.

Money statement.

July 1, 1887, amount available		$20,570.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,655.39	
July 1, 1888, outstanding liabilities	1,194.95	
July 1, 1888, amount covered by existing contracts	13,074.46	
		18,924.80
July 1, 1888, balance available		1,645.44
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,645.44
Amount (estimated) required for completion of existing project		149,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Burlington, Vt.; nearest light-house, Juniper Island; collection district, Vermont.

Arrivals and departures of vessels during year 1887.

Kind of craft.	Arrived.	Departed.
Steam-vessels with passengers and freight	469	469
Steam-tugs with tows	202	202
Sail and unrigged vessels	1,028	1,028
Total	1,699	1,699

The aforesaid vessels discharged the following at this port:

Coal	tons	81,150
Rough-sawed lumber	feet, B. M.	45,808,705
Shingles		5,222,500
General merchandise	tons	45,146

The above was received through the kindness of the collector of customs.

N N 8.

IMPROVEMENT OF OTTER CREEK, VERMONT.

The project for this improvement was adopted in 1872, and, as modified in 1882 and 1884, proposes the formation of a channel from Vergennes, Vt., to Lake Champlain, of a navigable width, and to afford a least depth of 8 feet. (See Reports of Chief of Engineers, 1872, page 273; 1882, page 712; and 1884, page 2159.)

The last operations under the above head consisted in the dredging of some 11,773 cubic yards of obstructing material from Bull Brook Bend and its vicinity in 1884, whereby much benefit was done the general navigation of the channel, and the improvement at this obstruction, which had been the most serious on Otter Creek, was perfected.

In order to complete the scheme of improvement, the channels at Sharkee's and Crittenden's bends, at Steam-boat Landing, and at the mouth of the creek should all receive attention, as contemplated in the original and modified projects.

Money statement.

July 1, 1887, amount available	$648.34
July 1, 1888, balance available	648.34
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	3,148.34
Amount (estimated) required for completion of existing project	37,248.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Vessels arrived and departed during the year 1887.

Kind of craft.	Arrivals.	Departures.
Unrigged and sail-vessels	112	112
Steam-tugs, yachts, and excursion vessels	168	168
Steam-vessels with passengers and freight	294	294
Total	574	574

Value of the aforesaid cargoes, $150,000. The above was obtained through the kindness of the collector of customs.

N N 9.

IMPROVEMENT OF TICONDEROGA RIVER, NEW YORK.

The project for this improvement was adopted in 1881, its object being the formation of a channel of navigable width and a least depth of 8 feet at low water between the falls at Ticonderoga village and Lake Champlain, a distance of about 2 miles. (See Report of Chief of Engineers, 1881, page 726.) The improvement was estimated to cost $42,516, of which amount $12,000 have been appropriated.

The amount appropriated by act approved August 5, 1886, $2,000, was pledged under contract dated March 9, 1887, the work comprehended in the contract being the removal of 10,000 cubic yards from the upper end of the channel.

Operations were commenced in the month of July, the water being at a favorable stage for carrying on the work; 10,870½ cubic yards were removed, and the contract was completed and closed in the month of August, 1887.

In order to fully carry out the scheme of improvement the channel should be widened in places and should be very generally deepened, so as to afford an 8-foot draught instead of a 6-foot draught, the work heretofore carried on having resulted mainly in securing the lesser depth, owing to the friable material of the abrupt banks left by the dredges ultimately reaching the channel. The parties directly interested in the improvement desiring to utilize the dredged material in raising the level of the adjacent ground that is submerged 2 or 3 feet by backwater from the lake at high water, and there being a saving in cost for dredging if scows are not required, the last contract provided that the material should be deposited alongside the cut, but this only increases the danger of the banks caving, unless the material so placed is at once removed to a distance from the edges of the cut. In any view of the case, the permanency of the improvement is decidedly questionable; for, whereas boats formerly reached the foot of the falls without difficulty, where the lake may have been said to receive the river, the lake and falls are now separated by some 2 miles of intervening swamp and lowland that has resulted from deposits, and unless the causes productive of so much filling are removed, accretions may be expected to continue. Doubtless these causes are not quite as active as formerly, there being probably less waste from mills, etc., now, but neither is the area in which the deposits take place as large as it was, the dredged channel merely forming a sort of narrow estuary of the lake, now, up to the falls, into which the river, with its sedimentary material, must pour; therefore a continuation of the deposits must be expected.

Since my personal inspection of the locality, and acquaintance with the commerce benefited and other concomitants of the undertaking, it is regarded as questionably worthy of improvement by the Government; and at the rate that operations can be carried on with the small appropriations that are made, it is probable they will not much more than keep pace with the filling of the channel by annual accretions. In view of all of which no further appropriations are asked for this improvement. If, however, it is deemed best to continue the improvement, it would seem to be the part of wisdom to appropriate a sufficient sum to complete the undertaking in one season's operations; since such a course might possibly enhance the commerce sufficiently to justify the maintenance of the improved channel afterwards.

Money statement.

July 1, 1887, amount available	$1,864.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,805.89
July 1, 1888, balance available	58.71
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,558.71
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	28,076.00

N N 10.

IMPROVEMENT OF NARROWS AT LAKE CHAMPLAIN, NEW YORK AND VERMONT.

The project for this improvement was adopted in 1885, and has for its object the removal of such obstructions in the channel between Whitehall, N. Y., and Benson's Landing, Vt., as will afford a least depth of 12 feet and a least width of 150 feet. The entire undertaking was estimated to cost $86,000. There were $30,000 appropriated for the work by act approved August 5, 1886. The most important portions of the improvement were duly advertised September 21, 1886; and contracts were made with Luther Whitney, of Keeseville, N. Y., for the removal of a rock-reef near the Elbow about a mile below Whitehall, N. Y., under date of October 21, 1886, and with John L. Johnson for dredging 100,000 cubic yards from Kenyon's Bay, under date of October 18, 1886, they having been the lowest bidders for each. The contract for rock excavation was completed and closed in July, 1887. It required the removal of the entire rock-reef, estimated to contain 600 cubic yards, so as to afford a 12-foot depth at low water, corresponding to 8.75 feet depth on the lower miter-sill of the lower rock at Whitehall, N. Y.

The examination before acceptance was made in a thoroughly searching manner. Instead of trusting to soundings a float was arranged with a 12-foot section of pipe held rigidly in a horizontal position at the required depth beneath it, which was carried back and forth over the excavated area, the motion being at right angles to the direction of the pipe. Nothing was encountered within the area of the excavation to interfere with such motion of the float.

Operations under the contract for dredging in Kenyon's Bay were continued through the season of 1887, but it became evident, before the season was far advanced, that work was not progressing fast enough to warrant an expectation that the contract would be completed on time. The attention of the contractor was called to his rate of progress, but only one dredge was placed at work; so that the contractor was obliged to ask for an extension of time for completion of his contract to July 30, 1888. A total of 85,282 cubic yards have been removed, under this contract, leaving 14,718 cubic yards to be removed in order to complete it.

There are now two dredges operating, and the contract as extended will doubtless be completed on time.

Additional funds would be expended in dredging mainly.

Money statement.

July 1, 1887, amount available		$26,858.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$16,333.35	
July 1, 1888, outstanding liabilities	6,264.97	
July 1, 1888, amount covered by existing contracts	2,502.07	
		25,100.39
July 1, 1888, balance available		1,758.55
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		16,758.55
Amount (estimated) required for completion of existing project		41,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		41,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Number of tows, boats, and tonnage that passed into and out of Whitehall Harbor:

Whole number of tows	470
Average number of boats in each tow	16
Total number of boats	7,520
Average number of tons carried by each boat ....gross	160
Total tonnage (tons of 2,240 pounds each, or 2,795,168,000 pounds passing through the Whitehall "Narrows" during the season of navigation of 1887	1,203,200
Estimated value of cargoes—	
Arrived	$2,300,000
Departed	2,200,000

The above was received through the kindness of the collector of customs.

APPENDIX O O.

IMPROVEMENT OF THE HARBORS OF OAKLAND AND REDWOOD, CALIFORNIA.

REPORT OF COLONEL G. H. MENDELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Oakland Harbor, California.
2. Redwood Harbor, California.
3. San Francisco Harbor, San Pablo and Suisun bays, Straits of Carquinez, and mouths of Sacramento and San Joaquin rivers, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 5, 1888.

SIR: I have the honor to inclose annual reports for the year ending June 30, 1888, on account of river and harbor works under my charge.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O O 1.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA

PROJECT.

The project is intended to secure a ship-channel with a low-water depth of 18 to 20 feet. The natural low-water depth at the junction of the channel with San Francisco Bay was 2 feet. The present depth is 9½ feet. The principal features of the project are, two stone jetties, rising 1 foot above high tide, extended from the shore to a depth of about 13 feet in San Francisco Bay; dredging between the jetties, and enlarging the tidal prism of the harbor by excavation of a basin and by introduction of the adjoining basin of San Leandro Bay by canal.

PRESENT CONDITION.

	Feet.
The present length of the north jetty is	9,203
The south jetty	11,868

The jetties are not fully completed.

The channel between the jetties has been dredged to a width of 300 feet, the middle third to a depth of 14 feet, and the sides to 10 feet approximately, leaving the remainder of the channel of less depth.

The dredging in the tidal basin lacks about one-third of completion.

A channel 100 feet wide in front of the city of Oakland has been dredged to a depth of 14 feet over a length of 4,300 feet.

The excavation of the San Leandro Canal has not been begun.

The flattening out of the cross-section of the jetty channel, noticed in the last annual report, resulting in diminished depth, while the section generally holds its own, or is increased, has continued during the year. There is at present a ruling depth of 9.5 feet in the jetty channel, giving 16 feet at spring tide high water, and about 14 feet at ordinary high water. The sides of the channel have been scoured, and deposits made along the axis.

The same is true to the extent of less than a foot in the narrow channel in front of Oakland, some filling having taken place from breaking down of the steep banks bordering the channel. About the mouth of the harbor no change worthy of note can be detected. Generally the cross-sections on the jetty channel, compared with the condition existing at the conclusion of last dredging in 1882, show a noticeable increase, which must be attributed to the increase of tidal prism developed by enlargement of the tidal basin.

THE JETTIES.

The last annual report contained a detailed statement of the condition of the jetties, to which reference may be made. The present condition is there described.

The dry masonry on the south jetty for a distance of 612 feet in several localities, was not completed at the time the masonry in the vicinity was finished. This needs to be completed as soon as practicable. The north slope of the north jetty has been disturbed by the action of waves, and needs a re-inforcement of stone, estimated at about 2,500 tons. About 500 square feet of the laid up masonry on this jetty has been disturbed by giving away of the slope. It will be necessary to replace this during the coming year.

No operations were carried on during the year, except those of supervision, including the survey necessary to ascertain the condition of the work at the close of the year.

FUTURE OPERATIONS.

The appropriation that may become available during the present fiscal year is to be applied to repair of the north jetty, to finishing uncompleted parts of the south jetty, to a short extension of the latter, to dredging in the tidal basin and in the channels, and to the excavation of the tidal canal, as the amount of funds available may justify.

The estimate for the succeeding year herein asked for, is to be applied to the same objects. The amount of funds which may be available for the current year not being known, it is impossible to be specific as to the work that may be undertaken. The excavation of the canal

is estimated to cost $413,442. The character of this work is such that it is poor economy to undertake it unless funds are available to put under contract the whole or a considerable part of it.

The growing commerce of Oakland requires that adequate provision be made to accommodate it, and to this end it is desirable that at as early a day as possible the channel in front of the city, now but 100 feet in width, should be made at least 200 feet in width, and it is also expedient that the channel between the jetties should have the depth of about 14 feet over a width of 300 feet. These results are to be secured by dredging.

Money statement.

July 1, 1887, amount available		$8,278.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,174.38	
July 1, 1888, outstanding liabilities	60.00	
		2,234.33
July 1, 1888, balance available		6,043.95
Amount appropriated by act of August 11, 1888		350,000.00
Amount available for fiscal year ending June 30, 1889		356,043.95

COMMERCIAL STATISTICS.

The following table compares the freight movement and passenger travel passing between the jetties in 1874, at the beginning of the improvement, with those now existing:

Years.	Traffic by steam-ferries.				Traffic by vessels.		
	No.	Trips.	Passengers.	Freight.	Number.	Register.	Freight.
				Tons.		*Tons.*	*Tons.*
1874	1	600	None.	60,000	1,415	70,750	94,300
1878	3	5,400	216,240	129,000	1,085	109,125	211,627
1882	3	8,800	858,362	1,051,788	1,129	129,714	173,448
1883	3	9,400	892,270	1,150,379	1,004	144,004	257,614
1884	3	8,000	974,901	1,142,948	1,031	143,886	215,829
1885	3	8,000	1,553,769	1,202,230	1,157	163,553	255,738
1886	3	6,000	444,142	1,439,134	1,326	200,226	305,437
1887	3	6,000	318,402	1,487,924	1,673	188,947	264,050
1888	3	8,520	210,423	1,654,451	1,224	130,913	231,660

By combining the above data into one grand total comparison we will obtain a more concise statement showing the final results attained:

Traffic.	1874, before improvement.		1888, after improvement.	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*
By ferry	None	60,000	210,423	1,654,451
By vessels	None	94,300		231,660
Grand totals		154,300	210,423	1,886,111

O O 2.

IMPROVEMENT OF REDWOOD HARBOR, CALIFORNIA.

The project is to dredge a channel 6,000 feet in length, for schooners, through the mud flat which lies adjacent to and below Redwood City. The tide rises from 4 to 6 feet, and with the proposed depth of 3 feet there will be 7 feet always at high water. The flat being bare at low water, the depth at high tide has generally been about 3 feet.

The vessels used in this trade have about 50 or 60 tons capacity.

In April, 1887, the Government dredge began work in this channel and continued until August 3, when it was withdrawn to work near Stockton. The channel was dredged for a length, of about 3,700 feet, to an average depth of 2½ feet and average width of about 50 feet, of which length 870 feet were dredged during July and August. The total amount dredged is about 30,000 yards of which 10,000 yards approximately were dredged during July and August. All dredged material was placed on shore.

The appropriation asked in the last Annual Report to complete the work was $7,400. This amount expended in the employment of the Government dredge will give a commodious channel, answering the needs of commerce, unless greatly increased, for a number of years.

There being no great extent of tidal area above Redwood City, and the channel receiving the wash from adjacent lands in freshets, any depth now obtained will continuously become less, and a few years may reproduce the condition of channel bare at low water.

The part of the channel upon which no dredging has been done is about 2,300 feet. Besides dredging this, it is expected to go over the part dredged during the past year, widening and straightening the cut, and giving it an uniform depth as far as is practicable.

The total amount appropriated to June 30, 1888, is $8,000 Amount expended $6,339.16.

Money statement.

July 1, 1887, amount available	$3,455.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,794.92
July 1, 1888, balance available	1,660.84
Amount appropriated by act of August 11, 1888	7,400.00
Amount available for fiscal year ending June 30, 1889	9,060.84

O O 3.

SURVEY OF SAN FRANCISCO HARBOR, SAN PABLO AND SUISUN BAYS, STRAITS OF CARQUINEZ, AND MOUTHS OF THE SACRAMENTO AND SAN JOAQUIN RIVERS, CALIFORNIA.

The last Annual Report stated the intention to make a survey of San Francisco Harbor, covering the field extending from Point Avisadero to the entrance.

The ground thus far covered by the survey extends from a parallel of

latitude 1½ miles south of Point Avisadero to a parallel one-half mile north of Red or Molate Rock, from latitude 37° 42′ to 37° 56′, not yet extended quite to the Golden Gate. The area covered is 110.5 square miles. It included the city fronts of San Francisco and Oakland. The number of casts of lead was 36,231. Eighty-six borings in the bed of the bay were made, and 271 samples of the bottom were taken. The field work was begun August 17, 1887, and continued to January 31, 1888. Subsequently special surveys were made of points which appeared to need detailed examination.

The survey is simply hydrographic, the shore-line being derived from coast-survey maps, which were kindly furnished on application.

The results are not at this date entirely embodied in map records, although nearly in shape. The completed sheets, on scale of 1 : 20000, are as follows:

1. Hydrography from Yerba Buena Island to Point Avisadero.
2. Hydrography from Point Avisadero to southern limit of survey.
3. Hydrography from Yerba Buena Island to northern limit of survey, including Raccoon Straits and Richardson's Bay.
4. Standard map of entire survey on mounted paper, including the areas of Nos. 1, 2, and 3.
5. Three sheets showing borings.

The general map embodying the information on the sheets of borings is in hand, and near completion.

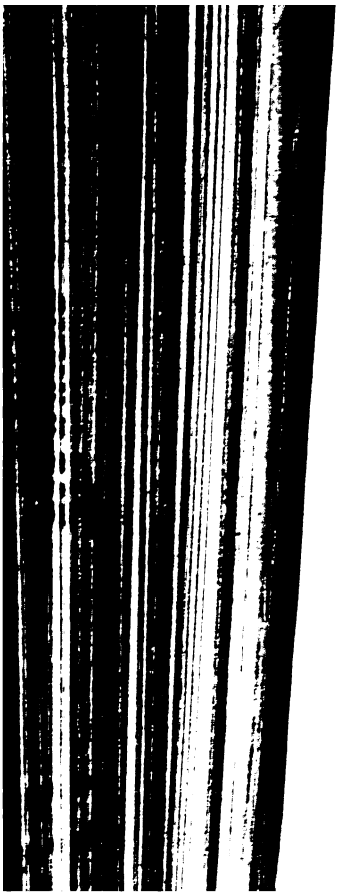
There are in hand 271 boxes labeled and numbered, containing samples of material taken from bottom of bay.

The study of data has not been fairly entered upon as yet. It may, however, be said that no great change in depth or commercial value of channels and anchorage-ground is noticed. The deposits made since the last survey of the bay are found mainly upon the flats. The samples obtained by borings were taken on shoals with the view to trace the deposits and refer them to the respective sources from which they are derived.

The money now available is not sufficient to extend the examination over the entrance to the harbor. The area necessary to include the approaches as far as the 10-fathom curve is about 100 square miles. The survey of this field will reveal the present condition of the bar, and by comparison with previous surveys trace the changes found to have taken place. While there seems to be no reason to expect that changes of importance have occurred since the last examination by the Coast Survey, and therefore no cause for apprehension of considerable deterioration in the bar channels, yet periodic surveys are extremely useful in tracing the progress of changes through a long course of years. The record of a survey now made will have value in future years by affording means of comparison.

Inasmuch as the survey of San Francisco Harbor, contemplated in the appropriation bill of August 6, 1886, is not complete unless the entrance be included, and for reasons of comparison already stated, a further appropriation is asked for continuance of the survey.

It is understood that the Coast and Geodetic Survey have either completed or have in hand the examination of San Pablo and Suisun bays, the Straits of Carquinez, and the mouths of the Sacramento and San Joaquin rivers, mentioned in the act of August 6, 1886. It is for this reason that no appropriation is asked to cover these areas, and that the operations of the Engineer Department have been, and are to be, confined to the hydrography of San Francisco Harbor, the survey of



Submitted in compliance with re
harbor acts of 1866 and 1867.

APPENDIX P P.

IMPROVEMENT OF THE HARBORS OF WILMINGTON AND SAN DIEGO, CALIFORNIA.

REPORT OF MAJOR W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Wilmington Harbor, California.
2. San Diego Harbor, California.

EXAMINATION AND SURVEYS.

3. Entrance and outer bar at San Diego, California.
4. Newport Harbor, California.
5. San Pedro Bay, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 2, 1888.

SIR: I have the honor to transmit herewith reports upon the works of improvement under my charge for the year ending June 30, 1888.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

P P 1.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

The improvement of this harbor was begun in 1871, at which time there was a depth at the entrance at low tide of about 1 foot. The operations carried on since have resulted in securing a greatly increased depth and width of channel, so that vessels drawing 15 feet can now enter the harbor and unload at the wharves. The project now in course of execution is intended to gain all possible depth at the entrance, estimated to be 14 to 16 feet at mean low water.

At the close of the fiscal year, June 30, 1887, two contracts existed for the prosecution of the work at Wilmington Harbor; one for dredg-

ing 135,000 cubic yards of material from the inner channel, and the other for the delivery of about 8,000 tons of rock for the west jetty.

The stone contractor commenced the delivery of material on the 25th of July, and completed his contract November 30, following. The total amount delivered was 8,198.46 tons, all of which was placed upon the west jetty. Owing to the inability of the contractor to commence the delivery of this stone on July 1, as stipulated in the contract, and not delivering the average monthly amount, he was unable to complete his contract at the date required, viz, November 1. The time was therefore extended to November 30, and the extra expense ($685.15) incurred by the Government was deducted from the contractor's account on final settlement.

The contract for dredging was entered into November 10, 1886, it being agreed that as the contractor, A. W. Von Schmidt, was then engaged with his machine at Oakland, he should be allowed to finish that contract before commencing at Wilmington. It making his proposal the contractor also stipulated that he should do the work with the machine known as the "Von Schmidt dredger." After considerable time spent in making the necessary repairs, the machine was taken to Wilmington in July last, for work at that point. After a month's trial it was found that the dredger was not adapted to the removal of the material of the character found to exist at various depths and at certain points in the channel. The contractor accordingly made application for the cancellation of his contract, which, after investigation, I recommended to the favorable consideration of the Department. This recommendation was approved by the Chief of Engineers November 15, 1887, and the contractor so informed.

After the cancellation of this contract, the balance of the appropriation on hand did not warrant me in calling for new bids for dredging as it was believed that any bids offered would be greatly in excess of that of Mr. Von Schmidt, which was 29.8 cents per cubic yard, the amounts previously paid in this harbor varying from 49 cents to $1 per cubic yard for sand, and even $2 asked, and as much as $2.40 for reef material. It was decided to hold the funds then available and combine the amount with that to be provided by the next appropriation bill, with a view of getting favorable bids for the prosecution of the work. It is to be regretted that the above indicated dredging operations could not have been carried to a successful termination, not only on account of the low price at which the work was taken, and the delay to the work consequent upon failure, but the fact that the natural order in which the operations of jetty building and dredging should now be carried on was reversed. It was intended to have the dredging of the inner channel in course of prosecution before commencing the jetty work, so as to avoid any scour that might be induced by this latter work, and the consequent deposition of the scoured material on the flat slope beyond the end of the jetty.

A hydrographic survey made towards the close of the fiscal year shows an improvement in the depths of the inner and outer channels, and an increase of depth over the crest of the outer bar. The short stretch near the angle of the west jetty, where only a depth of 10 feet at mean low water was found a year ago, has deepened to 12 feet, though the channel at one point is very narrow; this depth of 12 feet can now be carried throughout the entire length of channel inside and outside of Deadman's Island. There is no change to be noted in the condition of the jetties. Some slight needed repairs were made along the face of the single work, to prevent the wash of sand through broken portions of the work.

During the coming season (as far as the funds made available will permit) it is intended to dredge the interior channel and sand at the entrance, raise and extend the west jetty, and to keep the work in good order. These operations will be continued with any appropriations made in the future as a part of the present project.

At the close of the fiscal year the amount (exclusive of the funds on hand) estimated for the completion of the existing project was $175,000. Should the bill now before Congress make any appropriation for continuing the improvement, the amount that will be required for the succeeding fiscal year, and which should be asked for, will be the balance after deducting said appropriation from above amount.

The total amount appropriated for this harbor is $780,000 and the amount expended, including outstanding liabilities, is $735,126.60.

Wilmington is the nearest port of entry. The nearest light-house is Point Firmen.

There has been an increase of commerce over that shown in the last annual report. The amount thereof I am unable to give from the fact that I have not been able to hear from the collector, though I have written to him for the statistics of the port. Should this information be received in time to be embraced in the report, it will be forwarded to the Department.

Money statement.

July 1, 1887, amount available		$71,714.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,833.39	
July 1, 1888, outstanding liabilities	7.27	
		26,840.66
July 1, 1888, balance available		44,873.40
Amount appropriated by act of August 11, 1888		90,000.00
Amount available for fiscal year ending June 30, 1889		134,873.40
Amount (estimated) required for completion of existing project		85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		85,000.00

Commercial statistics for the year 1871.

Shipping.	Steamers.	Sailing vessels.	Freight.	Lumber.
	No.	*No.*	*Tons.*	*Feet.*
Incoming	160	65	25,313	10,938,336
Outgoing	160	65	9,575	.....

Commercial statistics for the year ending June 30, 1888.

*Foreign commerce.**		*Domestic commerce.*	
Entered:		Entered:	
Steam-vessels	8	Steam-vessels	432
Sailing vessels	67	Sailing vessels	739
Cleared:		Cleared:	
Steam-vessels	8	Steam vessels	432
Sailing vessels	30	Sailing vessels	766
Tonnage	88,040	Draught, greatest* ... feet	26
Draught, greatest ... feet	26½	Draught, greatest (inner harbor) do	15
Merchandise, general ... tons	5,282	Merchandise, general ... tons	49,900
Coal ... do	124,911	Coal ... do	1,200
		Lumber ... feet	195,368,000

* Refers to the "outer harbor."

The rates upon freight have been reduced since the first expenditure for the improvement of this harbor from $7.50 to $1 per thousand feet on lumber, and from to $5 $1 per ton on general merchandise from the outer anchorage.

PP 2.

IMPROVEMENT OF THE HARBOR OF SAN DIEGO, CALIFORNIA.

The work heretofore undertaken for the improvement of this harbor had for its object the control of the San Diego River, with a view of preventing the harbor from being a place of deposit of the material brought down by the river during its flood stages.

The improvement, commenced in 1875 and completed in 1876, consisted in cutting a new outlet for the river, causing it to empty in False Bay, and in building a levee closing up the channel of the river, and preventing the flow into the harbor. Since the completion of this project the work has consisted simply in keeping the levee in repair.

The general condition of the embankment is good, but it is in need of repair. It has been injured by the burrowing of animals and the wash of rain storms, and a portion of the rock facing has also been thrown down. Should the appropriation of $1,000 asked for in my last annual report be made, it will be expended in making these necessary repairs.

The amount appropriated since 1875 is $81,000 and the amount expended $80,958.09.

The river and harbor act of August 5, 1886, contained a proviso for the survey and estimated cost of obtaining a channel 250 feet wide and 24 feet deep at mean low water across the outer bar and thence to a point abreast of Beacon No. 2, in San Diego Harbor. This survey was made last year and the report thereon rendered to the Department under date of February 1, 1888, and printed in Executive Document No. 177, House of Representatives, Fiftieth Congress, first session.

This work is in the collection district of San Diego; that town is the nearest port of entry. The nearest light-house is at Point Loma, and the nearest fort is that begun at Ballast Point.

The collector of the port has been requested to inform me regarding the amount of revenue collected, and other commercial statistics, for the fiscal year ending June 30, 1888, but to date I have received no information thereon.

Money statement.

July 1, 1887, amount available	$111.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	69.28
July 1, 1888, balance available	41.91
Amount appropriated by act of August 11, 1888	1,000.00
Amount available for fiscal year ending June 30, 1889	1,041.91

PP 3.

SURVEY OF THE ENTRANCE AND OUTER BAR AT SAN DIEGO, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 1, 1888.

SIR: I have the honor to present the following report upon the survey of the entrance and outer bar at San Diego Harbor, California, as called for by the river and harbor act of August 5, 1886:

The section of the act referred to required a survey and an estimate

of cost of obtaining a channel 250 feet wide and 24 feet deep at mean low water across the outer bar and from thence to a point abreast of Beacon No. 2 in said harbor.

As surveys at other points along the southern coast of California were authorized by the same act, it was decided to organize only one party for the field work of all the surveys, commencing at San Diego and working thence up the coast, taking each locality in order.

Work was accordingly started at that place early in January with a party under charge of Mr. Otto von Geldern, and the survey was finished towards the close of February, having been interrupted occasionally by bad weather and accidents to the machinery of the steam-launch. The operations embraced a survey of the shore-lines on either side of the entrance to the harbor; a hydrographic survey from Beacon No. 4 to about 1 mile beyond the bar, extending also eastward over and beyond Zuninga Shoals, and observations to determine the direction and strength of the currents at the entrance.

The results have been plotted upon a map to a scale of $\frac{1}{10000}$, which is transmitted herewith; the plane of reference being that adopted by the Coast Survey.

A comparison of this map with that of the Coast Survey of 1879 shows that comparatively little change has take place within the area surveyed since that date. In fact, the only change noted is in the vicinity of the upper end of the middle ground inside the heads, north of Ballast Point. On the outer bar there has been practically no change in a number of years, the general depth of 21 feet at mean low tide has been maintained, and the width of about 1,000 feet between the 24-foot curves remains the same. At one point a depth of 19 feet was found, but only one sounding shows this depth. To the eastward and about 1,200 feet from the bar crossing and on the line of the Zuninga Shoals prolonged some shoaling has taken place over a small area, the depth having been reduced from 29 to 26 feet. This is the only place where any change has been observed outside and is simply noted here for reference, should the works to be constructed on the shoals produce any other changes. After crossing the bar the channel thence to the entrance has maintained its width and depth. Passing Ballast Point, entering the harbor, two good ship-channels formerly existed, one around to the west and north of the point and the other straight in between the middle ground and the extremity of the peninsula. The former shows no change, nor does the lower end of the middle ground, the 18 and 24 foot curves of this survey being almost identical with those of the Coast Survey of former years. The easterly channel, however, shows a shoaling near the upper end of the middle ground; this latter has extended northerly and easterly about 700 feet, and the channel has shoaled over a small area from 28 feet to various depths; one place 14 feet only having been found.

Passing the head of the middle ground the two channels join, and as there is a good depth beyond, the only place requiring improvement is the short stretch just noted. On the Zuninga Shoals the channel between the northerly end of the shoal and the mainland has a depth of 7 to 11 feet, which is a slight increase on former surveys, but otherwise no changes have taken place over the area of the shoals.

Summing up the results of the survey, it may be stated that there have been no changes affecting navigation, except the shoaling near the head of the easterly channel. Even on this inner bar a depth of 24 feet can be carried through, but the channel is too crooked for safe navigation. Entering the harbor the main channel turns westwardly

around Ballast Point and then northwardly, rendering it difficult for vessels not propelled by steam or in tow to take that channel, except under the most favorable conditions of wind and tide, while the easterly channel, being straight in from the entrance, would be the one used by all classes of vessels were the depth and width sufficient to carry them through without danger of grounding. To provide a channel 24 feet deep at mean low water, with a bottom width of 250 feet, would require the straightening of the existing channel for a very short distance and the removal of a very small quantity of material, in all not over 4,000 cubic yards. This channel-width required by the act I consider too narrow and would deem it more advisable to make it not less than 500 feet wide. This change would necessitate the removal of about 4,000 cubic yards of additional material, or 8,000 in all. The character of this inner bar, as determined by the bottom of the sounding-lead, is fine hard gray sand and broken shells.

Under date of January 9 a project was submitted to the Department recommending the construction of a dredge for work on the harbors along the southern coast of California. If the construction of this machine be authorized it could be used upon the work just indicated, and upon other work that will ultimately be required in the harbor. It could also be used, under favorable conditions of the sea, at times upon the outer bar; but the periods during which the machine could engage in outside work are so uncertain, and as the effects would be but temporary, it is not deemed expedient to place dependence upon such operations, but to gain an increase of depth over the bar that will remain permanent by the construction of a jetty along the Zuninga Shoals.

The depth on the bar is maintained by the volume and velocity of the water that passes over it. The supply to the tidal basin of San Diego is due entirely to the tide, as the streams that empty into the bay are unimportant, and for the greater part of the time may be considered as practically dry for any influence they may have in increasing the tidal prism. Taking a plane midway between high and low water would give an area of tidal basin of 20.9 square miles, and the tidal prism corresponding to a tide of 6 feet would give a discharge on the ebb through a mean section at the heads of about 160,000 cubic feet per second. The area of this mean section, taken on a line from the end of Ballast Point to the opposite shore, normal to the direction of the ebb current, is 75,776 square feet, giving a velocity in this case of a little over 2 feet per second. The width of this section is 1,630 feet, with a maximum depth of 73 feet.

To control a portion of the ebb flow beyond the heads and give it a direction so as to produce a greater working effect upon the bar, it is proposed to construct a jetty on Zuninga Shoals, about 7,500 feet in length, which will carry it out to the 15-foot curve. A section taken outside from Point Loma Head along the crest of the bar and thence along the proposed line of said jetty gives an area at mean tide of about 230,000 square feet. The proposed construction along the shoal will reduce this section by about 60,000 square feet. The jetty will be built of stone, and carried to half-tide, which height, while not materially interfering with the flood tide, will preserve the useful effects of the last half of the ebb. The line of the proposed work is along the westerly side of the shoals, which, at certain points, are bare at low tide, and as the force of the water will have been greatly diminished before reaching this line, it is deemed that a width of 12 feet on top with slopes of 1 on 2 will be sufficient. As the depth of water increases towards the outer end, the width on top will be increased to 20 feet with slopes of 1 on 3. The shore of the pen-

insula, from which the jetty will start, will be protected on either side a sufficient distance to prevent erosion from the action of the sea.

In estimating the quantity of material three-fourths of the volume given by calculation are taken, and each cubic yard is assumed to weigh 2 tons. As no boats or barges can cross the shoals, except at the highest tides, the stone for a portion of the jetty will have to be deposited from tramways built from the shore.

This will necessitate the building of a landing at the nearest convenient point, probably in the easterly channel above Ballast Point, and the building of a track to connect with this trestle-work.

The estimated cost of the jetty is—

56,000 tons in place, at $3.25	$182,000
70,000 tons in place, at $2	140,000
	322,000
Contingencies, 20 per cent	64,400
	386,400
Dredging	8,000
Total	394,400

I append herewith a statement of the commerce of San Diego for the fiscal year ending June 30, 1887.

The rapid increase of the commerce has furnished the occasion for allowing individuals and corporations to build wharves extending out into and encroaching upon the channel in such a manner as to injure navigation, and tending to interfere with the efficiency of the harbor. These constructions have already been commenced and many others are in contemplation, as increased wharfage facilities are demanded, to keep pace with the increase in commerce. They are located and built solely in the interest of the owner, and independent of any consideration as to the effect upon the future welfare of the harbor. Steps should be taken, by those having authority in the matter, to designate the manner in which these wharves should be built in the interests of navigation, and to preserve the tidal area of the bay.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major Engineers.

The CHIEF OF ENGINEERS, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Supervising Engineer.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 1, 1888.

Respectfully forwarded.

The design for this improvement seems to me to be judicious as to alignment, profile, and construction. After the work is brought to half-tide, it will probably appear to be advantageous to raise it for the greater part of its length to a level above high-water mark.

G. H. MENDELL,
Colonel, Corps of Engineers,
Supervising Engineer.

trance, 2,300 feet distant, the width was 2,200 feet and the greatest depth 5 feet, the sectional area being about 2,800 square feet, the channel on the bar at the time being to the west of the middle ground. When near the bluffs and east of the middle ground, the channel is in its most favorable condition for navigation; it gives better depths, is straighter, and does not change its direction so quickly as the other, but at best it gives but from 9 to 11 feet at the highest tides.

The section of the act authorizing the survey required an estimate of cost of obtaining a navigable channel at least 8 feet in depth at mean low water. The improvement necessary to be undertaken to gain the increased depth at the entrance would be with a view of controlling the volume of the tidal prism to a fixed channel. Having the rocky bluffs on one side, this would necessitate revetting the head of the sand-spit opposite and construction of jetties from the spit and from the rocky point, carrying the works out to a point where the bottom would cease to be disturbed by the waves. This would require that the works be carried out to the 7 or 8 fathom curve, making the length of the west jetty about 3,000 feet and the east jetty about 2,200.

Starting from the inner head of the sand-spit, which would have to be revetted for several hundred feet in length and above the highest water, the east jetty would be given a moderate profile as far as the 6-foot curve, which would carry it about 1,500 feet from the starting-point, the thickness on top being gradually increased to this point, where it would be 10 feet, with slopes of 1 on 3 on the outer side and 1 on 1 on the inner, the top being at the highest water. Thence to the outer end the thickness would gradually be increased to 20 feet, with slopes of 1 on 1 on the inner side and 1 on 3 on the outer to the depth of 18 feet below low water and below that 1 on 1. The east jetty would be given a similar construction, the lighter profile being carried out to the corresponding point as in the east wall, and the heavier profile thence to the outer end. The works must be projected upon a low sandy bottom, and exposed to storms from all points of the south. The ends of the jetties, the tops, and the outer sides must be built of heavy stones, to protect these parts from the effects of the severe southeasters and southwesters that occasionally prevail.

The estimated amount of material would be:

450,000 tons, at $2	$900,000
80,000 tons, at $4	320,000
	1,220,000
Contingencies, about 25 per cent	300,000
Total	1,520,000

In estimating this amount of material the solid contents of the jetties have been taken, and each cubic yard is considered to weigh 2 tons. Material can be obtained from the bluffs to the eastward and from different points of the estuary, where outcroppings of rock have been observed. It is probable that the heavier stones required would have to be brought from other localities.

To gain a depth within the estuary dredging would be required at various points, where the depth is only 7 feet and the channel narrow. In estimating the amount that should be removed, I have taken a channel 250 feet wide and 10 feet deep below mean low water, which would require the removal of about 200,000 cubic yards of material, the estimated cost of which, at 50 cents per yard, would be $100,000, which amount must be added to the above estimate.

I append a statement of the commerce of Newport Harbor. It was at one time the shipping and distributing point for the adjacent country. The construction of the railroad to Santa Ana, 12 miles distant, changed the method of transportation, and the business of the harbor declined. One small steamer arrives twice a month from San Francisco. This, with an occasional small lumber vessel, constitutes the carrying trade of the harbor. The cost of construction and maintenance of the works intended to give a permanent increase of depth at the harbor is entirely incommensurate with the advantages that would accrue to commerce.

The difficulties attending navigation over the bar prompted the steam-ship company to investigate the matter of building a wharf at a point some 3 miles up the coast, where still water existed, though otherwise the sea broke along the entire length of the beach. At the request of the agent the party was directed to make a survey of the locality, the results of which are plotted on the map, and designated the "New Landing." The still water is caused by a deep pocket making up close to the shore, with sand-spits to eastward and westward. These spits have from 5 to 6 fathoms of water upon them for a distance of about 2,500 feet from the beach, while in the depression the 10-fathom curve approaches within about 1,200 feet of the shore-line. It is generally smooth enough here to land a boat when the bar is in dangerous condition.

It is stated that arrangements are being made by the company to build a wharf at this point. If the structure can be maintained it will enable vessels to land and discharge their cargoes at certain periods of the year, but the situation is an exposed one, and open to winds and seas from all points of the south, which must prevent vessels from landing during heavy weather, and compel them, when their draught will admit it, to enter the estuary, and discharge at the old landing.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
(Through Col. G. H. Mendell, Corps of Engineers, Supervising Engineer).

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 23, 1888.

Respectfully forwarded. The views expressed herein are concurred in.

G. H. MENDELL,
Colonel, Corps of Engineers, Supervising Engineer.

Statistics of commerce for Newport Harbor, Cal., for the year ending December 31, 1887

		Incoming.	Outgoing.
Vessels		*24	*25
Tonnage		4,368	4,550
Draught, greatest	feet	8½	8½
Merchandise, general	tons	2,112.3	771.8
Coal	do	36.9	.....
Lumber	feet	500,000	.....

*All steam-vessels.

PP 5.

PRELIMINARY EXAMINATION OF SAN PEDRO BAY, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 8, 1886.

SIR: Having made the preliminary examination required in section 6, river and harbor act of August 5, 1886, I have now the honor to submit views which seem, to my mind, to justify a survey of the bay of San Pedro.

Although it is well known, it may be proper to state that there is no harbor for deep-sea vessels on the California coast, except that of San Francisco, occupying a central position, and that of San Diego, close to the southern limit of our territory.

The distance between these harbors is about 600 miles.

There are several roadsteads in the interval, which afford protection to vessels from winds coming from a particular direction, but none which covers from all winds.

The bay of San Pedro is the best known of these roadsteads, and is the only one which has now or ever has had foreign commerce.

A considerable fleet of deep-water ships is employed in foreign commerce from this port, the imports being mainly coal, and an export which is small and casual—wheat.

The amount of the foreign import trade for the year 1885–'86 can not now be stated in tons, but the duties collected at the Wilmington custom-house were, for that time, $61,624.83.

The bay of San Pedro is the best of these roadsteads, and is, moreover, the point where the Southern Pacific system of railroads, coming from the east, first touches the Pacific Ocean. It derives commercial advantage, as compared with San Francisco, from the fact that it gives much the shorter and easier line of overland transportation to the waters of the Atlantic, for Asiatic commerce.

The loading and discharging of deep-water ships are now effected through the use of lighters, which carry the freight between the shore and the anchorage of the vessels, a distance of 2 or 3 miles. The tax upon commerce resulting from this system is made considerable, not only by the direct cost of this method of transshipment, but by the delay thereby imposed upon vessels.

If the ships were enabled to lie alongside of piers and discharge their freight in the usual way, the saving in cost would be considerable. Until such a system of discharge is provided, it is not probable that Asiatic commerce could take this route. This commerce being carried on by steamers, the delays incident to a lighterage system would involve so great expense as to take this port out of the field of competition.

Heretofore there has been no competition between Pacific ports for the Asiatic trade. It has naturally come to San Francisco. But a different phase is at hand. The Canadian Pacific Railroad, already in operation, on the one hand, and the Northern Pacific, now in course of extension to the waters of Puget Sound, on the other, promise to introduce two competitors for the overland transportation of Asiatic commerce.

The topographical conditions of overland routes become elements of importance in this competition. Between San Francisco and Los Angeles there are two considerable mountain elevations to be crossed, and

a distance of about 500 miles. Equating the resistance of elevations with linear resistance it will appear that the advantage of San Pedro as compared with San Francisco in overland competition is something like 800 miles.

The information is not at hand to institute a comparison either with the Northern Pacific route from Seattle, Wash., or with the route from San Diego, Cal., which is also a terminus of a railroad system, connecting with the east by means of the Atchison and Topeka road.

The harbor of San Diego is capacious and favorable in point of shelter and depth for any amount of commerce that can be imagined in the future. It lies 90 miles to the southward and eastward of the bay of San Pedro.

It may be a question whether or not it is advisable to expend a considerable sum in building an artificial harbor at San Pedro, when there is now a fine natural harbor at San Diego, 90 miles distant.

San Pedro has advantage over San Diego in the light grades found on its railway route from the coast to San Bernardino; but the measure of this advantage can not now, from want of information, be stated.

San Pedro has now, however, a much larger foreign trade than San Diego. It remains to recall that Wilmington Harbor, which debouches into the bay of San Pedro, has been much improved by the United States, and that it now is a harbor for vessels of 12 to 14 feet draught. The coasting commerce is now practically carried on through this harbor. It is a small estuary and can never be made a harbor for deep-water ships. If 18 or 20 feet at high water can be obtained, the harbor will have received its maximum development. This harbor is 20 miles from Los Angeles, the second city in importance of California, and the center of a highly developed area of horticultural and viticultural industry.

This circumstance and the direct rail connection with eastern territory have given rise to a considerable commerce in the little harbor of Wilmington.

While this harbor can never be made to accommodate large ships, yet the existence of a large coast commerce tends to attract to this point foreign commerce.

It will appear from the considerations thus so meagerly sketched that the question of the improvement of San Pedro Bay is connected with the problem of competition for the Asiatic trade, which is supposed by competent authorities to be yet in its infancy.

As an element of perhaps national importance, as it may be if the Canadian Pacific route attracts commerce, the question appears to me to be deserving of careful examination and study, and I recommend the place as "worthy of improvement."

As to cost of survey and project I beg to submit the sum of $4,000, mentioned in my letter on this subject, dated May 19, 1885, in answer to Department indorsement of April 18 on Senator Stanford's letter of April 13. If this sum can not be allotted, the most will be made of a smaller sum, which, in any event, it is hoped will not be less than $2,500.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF SAN PEDRO BAY, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 13, 1888.

SIR: I have the honor to present the following report upon the survey of San Pedro Bay, with a view to establishing an outer breakwater for the protection of deep-draught vessels, as provided for in the river and harbor act of August 5, 1886.

After the completion of the survey of Newport Harbor the party, under charge of Mr. Otto von Geldern, was transferred to San Pedro for the above-indicated work. Operations were commenced during the last week in March and continued until the 10th of June, when the party was discharged and the assistant brought to the office for the purpose of working up the notes of this and the other surveys and making the maps of the different localities surveyed. The hydrographic work in the bay covered an area extending from the entrance to the inner harbor out some 2 miles beyond and southeast of Point Fermin, and easterly from that point about 4 miles. It was intended to cover a larger area and also to make a series of current observations in the bay, but the amount allotted for the work was inadequate to cover all the ground; the work accomplished affords sufficient information to enable us to indicate the position of a breakwater that would afford shelter to the anchorage-ground and to give an estimate of the cost of the structure. The results of the survey have been plotted upon a map to a scale of $\frac{1}{10000}$, which is transmitted herewith.

Before the improvement of the inner harbor was commenced there was only a depth of about 1 foot upon the bar at the entrance at mean low water. This depth has been increased by the works projected to 11 feet, and it is expected that a depth of 16 feet at mean low water will ultimately be gained. This depth will enable a certain class of vessels to enter the harbor and unload at the wharves, but the larger steamships and other deep-draught vessels will be compelled to lay off-shore and have their passengers and freight transferred to lighters.

Good holding ground exists at the anchorage, which is protected from the north, but is open from the east around by south to the west, and exposed to the southwest and southeast gales that prevail during the winter months. South from Point Fermin, and distant some 18½ miles, Catalina Island, 17½ miles in length, aids in sheltering the bay from heavy swells from the south, but the southeasters and southwesters approach the roadstead through the open areas to the east and west of the island. Vessels are frequently compelled during the prevalence of southerly gales to leave their anchorage and seek shelter under the lee of the islands that lie off the coast. The wrecks of vessels found along the west shore of the bay would seem to indicate the southeast as the quarter from which the heaviest storms come, but with the exception of these occasional gales there is otherwise a heavy swell that sets in from the southwest. For the purpose of affording a protected anchorage-ground, as contemplated by the act, it is proposed to construct a breakwater, the position of which is indicated on the map.

Starting at the 3-fathom curve at a point inside of Point Fermin, a direction south 47 degrees east is given to the westerly arm of the breakwater for a distance of 3,300 feet, which carries it beyond a line projected from the anchorage-ground to the westerly end of Catalina Island, and gives protection to seas from the southwest. A gap of 1,000 feet is then left, and the westerly arm, 2,500 feet long, running north 75 degrees east, is loca-

ted so as to extend beyond lines drawn from the anchorage ground as above to the easterly end of Catalina Island and Point San Juan Capistrano, and affords shelter from seas coming from the southeast between those two points. The gap is covered from the southerly seas by Catalina Island as before mentioned. The position of the two arms of the breakwater, thus approximately fixed, may be changed within slight limits, as further study of the conditions may seem necessary. Vessels may use the gap or they may go around the westerly end either for entrance or exit, according as the direction of the wind may render either course desirable; the openings left will allow a free circulation of the currents, and tend to prevent any deposition of material within the sheltered area. For the form of the cross-section I have taken a width on top of 25 feet, 10 feet above high water of spring tides; on the outside a slope is given of 1 on 3 to a point 18 feet below low water, and below that point 1 on 1. The slope on the inside is 1 on 1. The breakwater will be formed of stones of various sizes dropped in place; the portion below 18 feet below low water and the interior will be of ordinary quarry material, and the slopes on both sides above that point, and the top will be of blocks of larger dimensions. Judging from previous operations abundance of stone of fair quality can be obtained at Catalina Island. The working of the quarries the past summer shows also that stone of the larger dimensions required could be obtained. In estimating the quantities of material, three-fourths of the volume given by calculation are taken, and each cubic yard is supposed to weigh 2 tons.

There will be required:

For the westerly arm:		
702,000 tons, at $1.50		$1,053,000
141,000 tons, at $4		564,000
		1,617,000
For the easterly arm:		
862,000 tons, at $1.50	$1,293,000	
152,000 tons, at $4	608,000	
		1,901,000
		3,518,000
Contingencies, 15 per cent		527,700
Total		4,045,700

This estimate of cost is based upon the supposition that funds for carrying on the work will be appropriated in such amounts as will enable a proper outfit of barges, etc., to be provided for carrying the material from the quarries to the site. If we have to depend upon the means of transportation usually furnished, in the way of small sailing vessels, the cost must necessarily be increased.

The breakwater, in addition to affording a protected anchorage ground, will also permit the construction of wharves along the westerly shore of the bay, at which deep-draught vessels can lie with safety, and discharge their cargoes free from the expense now entailed by lighterage. The commerce, both foreign and domestic, that seeks an entrance in San Pedro Bay is on the increase, as shown by the comparative statement herewith, and it would undoubtedly increase still more rapidly as the country is developed and additional facilities afforded for transportation to interior points, were there any certainty that the protection to the roadstead would be inaugurated. While at the present time this commerce might not be considered commensurate with the expense, it

must be remembered that the breakwater, if commenced, will require a number of years for completion, at the rate appropriations are usually made, and that by the time this period arrives the commerce might fully warrant the expenditure.

The survey developed the existence in the bay of a rock (noted on the chart) whose top is 18 feet below the plane of mean low water. Any contemplated improvement in the outer bay should also include the removal of this rock to a depth of at least 24 feet below said plane.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major Engineers.

The CHIEF OF ENGINEERS, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Supervising Engineer.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 13, 1888.

Respectfully forwarded.

This project appears to be well conceived. San Pedro Bay is partially covered from sea exposure by the high island of Santa Catalina. The westerly breakwater covers the sea interval between the northern end of the island and the mainland. The easterly breakwater covers the interval between the southern end of the island and San Juan Capistrano, on the mainland. Thus the whole arc of exposure is covered. There are two entrances from the sea, one of which is always convenient for arrival and departure, whatever be the direction of the wind. One of the entrances is covered by Catalina Island and the other by the mainland adjacent to San Juan Capistrano. Circulation by littoral currents is provided. The profile of the work is thought to be adequate. With large sizes of stone it is propable that the sectional area may properly be reduced, as storms and heavy waves do not here occur so frequently nor so violently as is the case on the northern coast.

G. H. MENDELL,
Colonel, Corps of Engineers,
Supervising Engineer.

Statistics of commerce, Wilmington Harbor, California, for the year ending December 31, 1871.

	Incoming.	Outgoing.
Vessels:		
Steam	160	160
Sailing	65	65
Freight ..... tons	25,313	9,575
Lumber ..... feet	10,938,336	.....

Statistics of commerce, Wilmington Harbor, California, etc.—Continued.

FOREIGN COMMERCE.

	Incoming.	Outgoing.
Vessels:		
Steam	3	4
Sailing	63	61
Tonnage	79,320	78,065
Greatest draught ... feet	*26	*26
Merchandise:		
General ... tons	841	.....
Wheat ... do	.....	1,332
Coal ... do	129,341	.....

*Refers to the outer harbor.

DOMESTIC COMMERCE.

Vessels:		
Steam	321	348
Sailing	465	457
Tonnage	464,770	458,045
Greatest draught ... feet	18	18
Merchandise:		
General ... tons	44,928	17,400
Lumber ... feet	163,328,000	.....

Amount of revenue collected at the port during the year ending December 31, 1887, $113,100.73.

APPENDIX Q Q.

IMPROVEMENT OF ENTRANCE TO HUMBOLDT BAY, OF SAN JOAQUIN, MOKELUMNE, SACRAMENTO, AND FEATHER RIVERS, AND PETALUMA CREEK, CALIFORNIA.

REPORT OF MAJOR WILLIAM H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. San Joaquin River, Stockton and Mormon Sloughs, California.
2. Mokelumne River, California.
3. Sacramento and Feather rivers, California.
4. Petaluma Creek, California.
5. Humboldt Harbor and Bay, California

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 2, 1888.

GENERAL: I have the honor to transmit the annual reports of the river and harbor works under my charge for the fiscal year ending June 30, 1888. Previous to November 23, 1887, these works were under the charge of Capt. A. H. Payson, late Corps of Engineers.

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Q Q 1.

IMPROVEMENT OF SAN JOAQUIN RIVER, STOCKTON AND MORMON SLOUGHS, CALIFORNIA.

The approved project adopted in 1877 and slightly modified in 1881 has for its object the securing and maintenance, by dredging, of a channel 9 feet deep at low water and 100 feet wide through the tidal parts of the river and Stockton Slough below Stockton, a channel 4 feet deep and 80 feet wide to Miller's warehouse in Mormon Slough, and temporary improvement to the low-water channel of the Upper San Joaquin

River to Hill's Ferry. The latter work done by the United States snag-boat and crew.

The total amount expended on the river and sloughs to June 30, 1887, has been $144,880.44, and during the past fiscal year an additional amount of $13,073.92 has been spent, making a total to date of $157,954.36.

During the last fiscal year the United States dredge-boat has been in commission and at work on Stockton Slough and at Dutchman's Reach, on the main river, from August 11, 1887, to March 13, 1888. In Stockton Slough a channel was excavated on the south side of the slough 50 by 9 by 7,663 feet in length, and on the north side a channel 50 by 9 by 2,200 feet in length was made. At Dutchman's Reach the dredge cut a channel 150 feet wide, 850 feet long, and having a depth of 9 feet at low tide.

The total amount of material dredged aggregated 144,975 cubic yards, all of which was deposited on the shore, the average monthly running expense of the dredger and crew was about $2,000, and the amount of material dug and pumped ashore averaged a little over 20,000 cubic yards per month, making the actual cost of the work to the United States about 10 cents per cubic yard. In previous annual reports reasons were given why a radical and permanent improvement was unjustifiable. Immediate relief could be given to navigation when demanded by sending the snag-boat up to remove the worst snags when the stage of the river would permit. This part of the river is only navigable six to seven months in the year as far up as Hill's Ferry, and then only for boats drawing 2 feet or less of water.

At Laird's Slough there is a crevasse, and parties interested in the navigation of the upper river desire its closure, claiming that the crevasse shoals the river opposite to and near the crevasse, and threatens to make a cut-off and leave its present channel, on the bank of which the town of Grayson is situated. This would leave the town a half mile or more from the river. It is also possible that the closure of the crevasse would result in the giving of a few weeks longer navigation in each year, but the danger from a closure of this crevasse is that it may endanger the banks above and below. A special report was made on this subject May 2, 1888. The estimated cost of closing the crevasse was $9,570.

The partial closure of Paradise Cut has been recommended and estimated for, but the appropriations were too small and other work too important and pressing to warrant the work on Paradise Cut. The estimated cost for the low dam for this cut was $14,000. The cut-offs at Twenty-one Mile Slough and Head Reach were estimated to cost $125,000, making the total estimated cost of doing the work herein mentioned, exclusive of the annual dredging and occasional snagging, $148,570.

The channels below Stockton can only be maintained by annual dredging. Stockton Slough requires almost constant dredging.

We now have our own dredge, and can do our own dredging at a cost very much less than has been paid for work at these localities by contract. The benefits to commerce certainly warrant the expenditure of the money required.

With future appropriations it is proposed to continue work on the adopted project, and, unless otherwise directed by Congress, in the following order, depending on the amounts appropriated and the requirements of commerce:

(1) Dredging to get and maintain 9 feet to Stockton.
(2) Snagging and scraping in upper river.
(3) Building low dam at Paradise Cut.
(4) Making new cut-off, as heretofore recommended, or closing Laird's Slough.

Estimated amount that could be profitably expended in the fiscal year ending June 30, 1890, are for—

Dredging	$24,000
Snagging	16,000
Closing Paradise Cut	14,000
Closing Laird's Slough	9,570
Estimate for one cut-off	65,000
Total	128,570

Money statement.

July 1, 1887, amount available	13,869.56
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	13,073.92
July 1, 1888, balance available	795.64
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,795.64
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	103,570.00

Statistics for eleven months ending May 31, 1888.

[Furnished by the Hon. H. J. Corcoran, manager San Jeaquin Improvement Company.]

Wheat	tons	134,638	Merchandise	tons	30,000
Coal	do	44,000	Paving stones	do	15,000
Sundries	do	4,530	Brick		2,000,000
Potatoes	do	40,000	Lumber	feet	21,545,000
Flour	do	58,000	Wool	bales	6,000

Q Q 2.

IMPROVEMENT OF MOKELUMNE RIVER, CALIFORNIA.

The project was adopted in 1884, and had for its object the removal of snags and overhanging trees which obstructed navigation between the mouth of the river and Benson's Ferry. Both forks of the river were cleaned out to the head of navigation at a cost of $10,960.58. No work was done during the last year, as no funds were available. Obstructions have again formed and will continue to do so. Work for the snag-boat will occasionally be required so as to get rid of these snags. It is estimated that $2,000 can be spent to advantage in the fiscal year ending June 30, 1890.

Money statement.

July 1, 1887, amount available	$39.42
July 1, 1888, balance available	39.42
Amount appropriated by act of August 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,039.42
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

Statistics for eleven months ending May 31, 1888.

[Furnished by the Secretary of the California Transportation Company.]

Merchandise carried	tons	1,025
Grain and produce carried	do	35,000
Passengers		1,600

Q Q 3.

IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

The approved project had for its object the temporary improvement of the low-water channel by snagging, dam building, and bar scraping. Most of the work has been done by the United States snag-boat and by hired labor.

Owing to lack of funds, by reason of failure of the last river and harbor bill, the snag-boat *Seizer* was only at work twenty-nine days during the past fiscal year. She worked in a reach of the river about 45 miles long, just above Colusa, and removed 283 snags, blasted away a projecting point of river at Hemstreet's Bend, built two wing-dams of snags, fascines, and sand-bags near Walsh's Cut-off. The dams were 350 and 200 feet long respectively. She also blasted out and washed a channel through a bar near these dams and obtained a channel 3½ feet deep over the bar. The bar was composed of gravel, cemented together with clay. Six hundred and sixty-seven pounds of Tonite powder were used in blasting.

It is believed that a continuance of the methods heretofore adopted on these streams is the only practicably economical method of keeping them in a navigable condition. The permanent improvement of that portion of the river above Colusa, while perhaps practicable, would be so expensive as to be unwarranted with the present or prospective commerce of that section of the State. Without the annual use of the snag-boat in this section of the river it would be so injured by the accumulation of snags as to materially interfere with the movement of the immense wheat crop of this section except at greatly increased rates of freight by rail transportation.

Since the use of the United States snag-boat in 1881 the river has been kept in fairly good boating condition, the expenses of transportation have been reduced, commerce has increased, and the expense of removing the snags by snag-boats, as compared with prices paid contractors heretofore, is less than one-half, and accidents to boats or barges are now of the rarest occurrence. The upper part of the river is really in a better boating condition for the class of boats which use it than is the part of the river at and below Sacramento.

The snag-boat and barge are in reasonably good condition, and will only require such overhauling to resume work as would be the case with any floating craft that had been lying idle for nearly a year. Complaints are now coming into the office that the river near Walsh's Cut-off is become troublesome, but as there is less than $1,500 available, and it will cost this much or more to fit up the snag-boat for service, and as her running expenses are about $4,000 per month, it is impracticable at present to render the boatmen any assistance.

Since 1875 Congress has appropriated for these rivers $445,000, of which $329,612.87 have been spent, including the cost of construction of a dredge, snag-boat, and two barges for use on them. There is yet unexpended $115,387.13, of which only $1,193.26 is available, as Congress, by its act of July, 1884, prevented the expenditure of funds on these rivers except as provided in that act, and not until the Secretary of War should be satisfied that hydraulic mining on the Sacramento and its tributaries had ceased. That hydraulic mining has not entirely ceased is evident from the occasional injunctions granted, but the amount as compared with what was done in former years is insignificant.

Below the Feather River the Sacramento River continues to deteriorate, because the mining débris deposited in former years continues to be washed into the stream and is rolled and pushed along the bottom during floods. The following is a list of appropriations made for the Sacramento and Feather rivers:

March, 1875	$15,000
July, 1878	15,000
March, 1879	20,000
July, 1880	45,000
March, 1881	60,000
August, 1882	250,000
July, 1884	40,000
Total	445,000

With any moneys that may be appropriated in the future it is proposed to continue work with the snag-boat as heretofore.

Money statement.

July 1, 1887, amount available	$124,200.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,813.84
July 1, 1888, balance available	115,387.13
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	135,387.13
Amount that can be profitably expended in fiscal year ending June 30, 1890. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	60,000,00

Statistics for eleven months ending May 31, 1888.

[Furnished by Captain Dwyer, president Sacramento Transportation Company.]

	Tons.
Up-freights carried by boat, consisting of merchandise, lumber, and coal	80,010
Down-freight, sconsisting of bricks, merchandise, broom-corn, hay, wheat, barley, wood, corn, and other products	203,352
Total	283,362

Q Q 4.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

The project adopted in 1880 aimed to straighten the estuary by cut-offs and to obtain, by dredging, a channel about 8,000 feet long, 50 feet wide, and 3 feet deep at low water.

Before improvement the channel was very crooked and was bare at low water. In 1884 the work was completed, at a cost of $2,343.09. Since then nothing has been done until within the present fiscal year. The channel has been gradually refilling and has for a year or more been in places bare at low water. Actual survey developed the fact that in some spots in the channel filling had taken place to such an extent that parts of the bottom at low tide were 2 feet above low-tide level. The only steam-boat plying on the creek had to time her trips so as to do her creek work during high-tide stages only.

With the balance available proposals for dredging were invited, and the only bid received was 25 cents per cubic yard. Contract was made and during the past month the dredge has removed about 6,000 cubic yards of material from the channel and cleaned out 1,400 running feet of channel. The whole work will be completed, as far as the funds will permit, in about one week more and will result in a channel that will have the worst obstructions removed and enable boats to get to Petaluma at half-tide stages. It is thought that the present work will give a channel that at least is not bare at low water and will relieve the immediate wants of navigation. It will be impossible to maintain a channel in the upper part of the creek, except by repeated dredging. All the sewage of Petaluma and the drainage and washings from the highly cultivated valley lands get into this small creek, which is only about 60 feet wide.

The digging below where we are now going is generally hard pan and will be much more expensive to remove than the present soft material. The annual commerce on the creek is sufficient to warrant a depth of 4 or 5 feet of water, measured at low tide, and while in the absence of exact surveys the quantity of material to be excavated to produce this depth is not definitely known, it is roughly estimated that about 60,000 cubic yards of hard pan will have to be removed, at an estimated cost of 50 cents per cubic yard, or $30,000 as an approximate estimate for the whole cost of the work. If this work be done an occasional cleaning out of the soft material by a dredger, say once every four or five years, ought to maintain a good navigable channel.

Money statement.

July 1, 1887, amount available		$2,343.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$210.24	
July 1, 1888, amount covered by existing contracts	2,132.85	
		2,343.09
Amount appropriated by act of August 11, 1888		2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		28,000.00

Statistics of freight carried on Petaluma Creek during the present fiscal year, furnished to the trustees of the city of Petaluma and by them published as substantially accurate.

Articles.	Quantity.	Articles.	Quantity.
Wheat ... tons	10,000	Leather ... tons	[illegible]
Barley ... do	5,000	Ice ... do	[illegible]
Hay ... do	13,000	Wool ... do	[illegible]
Oats ... do	1,500	Hops ... do	[illegible]
Corn ... do	400	Merchandise ... do	[illegible]
Wood ... cords	1,250	Butter ... do	[illegible]
Tanbark ... do	100	Cheese ... do	[illegible]
Bricks	200,000	Canned goods ... do	[illegible]
Eggs ... dozen	648,000	Hides, green	[illegible]
Live-stock	60,000	Sheep-pelts	[illegible]
Potatoes ... tons	10,000	Lumber ... feet	[illegible]
Flour ... do	850	Shingles	[illegible]
Bran and feed ... do	2,250	Pickets	[illegible]
Salt ... do	1,000	Laths	[illegible]
Coal ... do	2,500	Veals	[illegible]
Paving blocks ... do	100,000	Passengers	[illegible]
Fruit ... do	4,850		

Q Q 5.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

The project for improvement was adopted in 1881. It aimed to secure low-water channels 13 feet deep, 200 feet wide to the head of the Eureka wharves, and 10 feet by 100 feet wide to Arcata and Hookton. In 1882 an additional project was made to increase the depth of water over the bar at the entrance to the harbor by the construction of a training-wall built to the level of low water and extending from the South Spit seaward in a northwesterly direction. The estimated cost of the sea-wall alone was $600,000.

The dredging work herein referred to (the improvement of the channels to Eureka, Arcata, and Hookton) was completed in 1884. Some deterioration has occurred to the channels, especially in front of the Eureka wharves and at the junction of the Eureka and Arcata channels. These channels are not self-maintaining, owing to the sluggish current. They also receive the sewage of the towns. Their depths and widths can only be maintained by occasional dredging.

The act of August 5, 1886, making appropriation for the improvement of the entrance to the bay, prohibited the expenditure of money until the United States had acquired, free of expense, the title to the land required on the South Spit. Nearly the whole of the last fiscal year has been spent in correcting imperfections in the deeds to the property, having probate proceedings corrected, and in getting an opinion from the United States district attorney, so as to secure a proper deed for the property referred to.

Within the past week a deed to the property has been obtained, the acting United States attorney has approved it, and it has been forwarded to Washington for formal approval by the United States Attorney-General.

With the money available and asked for it is proposed to make preparations for and commence the construction of the training-wall. Authority has also been received to permit the use of brush in the training-wall where economical and practicable, and to protect the North Spit against erosion if necessary.

No close or final estimate of the cost of obtaining and maintaining a deep permanent channel over Humboldt Bar has been or can at present be made. The only estimate submitted is for a training-wall built to the level of low water. Should this training-wall have to be built higher or longer, or shore protection on the north sands or spit be required, the cost will be additional and depend entirely on the amount of additional work required

The appropriations for improvement of Humboldt Bay have aggregated $217,500, of which amount $80,884.69 has been spent, and nearly all for the dredging of the channels inside the bay. The balance available ($136,615.31) will make a good start in building the training-wall.

Money statement.

July 1, 1887, amount available	$136,615.31
July 1, 1888, balance available	136,615.31
Amount appropriated by act of August 11, 1888	125,000.00
Amount available for fiscal year ending June 30, 1889	261,615.31
Amount (estimated) required for completion of existing project	412,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Full commercial statistics for the past year can not at present be obtained. The collector of customs at Eureka reports a foreign export of lumber and saw-mill products valued at $101,169. Seventeen vessels entered and eighteen cleared for foreign ports. Six hundred and nine sailing vessels left the port, each with an average carrying capacity of 250,000 feet of lumber, making a total output of lumber of about 152,000,000 feet in the shape of sawed lumber, shingles, shakes, posts, and pickets. In addition to the above, one hundred and sixty-five steamers sailed with full cargoes of miscellaneous freights.

A published statement of the commerce or shipments from Humboldt County for the fiscal year ending June 30, 1887, is the latest full information available, and from said statement the following is compiled:

Articles.	Quantity.	Articles.	Quantity.
Lumber.....feet..	104, 519, 726	Eggs.....boxes..	237
Shingles.....thousand..	203, 700, 985	Fish.....pounds..	428, 000
Shakes.....do....	17, 240, 523	Hides.....bundles..	540
Posts.....do....	82, 153	Oats.....sacks..	26, 840
Apples.....boxes..	6, 733	Potatoes.....do...	40, 100
Butter.....pounds..	92, 000	Pease.....do...	6, 020
Barley.....sacks..	1, 951	Salmon.....barrels..	408
Cheese.....pounds..	2, 000	Live-stock.....head..	2, 000
Beans.....do....	4, 479	Wool.....pounds..	1, 594, 925

APPENDIX R R.

IMPROVEMENT OF THE ENTRANCES TO COOS AND YAQUINA BAYS, OF MOUTH OF COQUILLE RIVER, AND OF UMPQUA RIVER, OREGON.

REPORT OF CAPTAIN WILLARD YOUNG, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mouth of Coquille River, Oregon.
2. Entrance to Coos Bay, Oregon.
3. Umpqua River, Oregon.
4. Entrance to Yaquina Bay, Oregon.

EXAMINATION AND SURVEY.

5. Tillamook Bay and Bar, Oregon.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, July 3, 1888.

SIR: I have the honor to forward herewith the annual reports for the fiscal year ending June 30, 1888, for the works of improvement of rivers and harbors which have been under my charge.

Very respectfully, your obedient servant,

W. YOUNG,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

R R 1.

IMPROVEMENT OF THE MOUTH OF THE COQUILLE RIVER, OREGON.

DESCRIPTION OF ORIGINAL CONDITION.

The mean rise of tide is 4.1 feet.

At the time the work of improvement was begun the entrance to the Coquille River was considered very dangerous. It was by a long, tortuous, and narrow channel skirting the south headland, and was

studded with rocks from beyond the bar on the ou
one-half mile inside. The depth at low water ov
about 3 feet, while the position of the bar channel
ing. The channel sometimes, at long intervals a
the north spit and ran directly out to sea, just sou
but did not remain long in this position. The en
was comparatively safe, and the channel was at its

PLAN OF IMPROVEMENT.

The plan of the improvement is to open and
through the north spit, and running directly out
Rackliffe Rock, by building a jetty on the south s
beginning at a point on the left bank inside the e
across the north spit at a distance of 800 feet south
and in a direction nearly west.

AMOUNT EXPENDED AND RESULTS OBTAINED

The amount expended to June 30, 1887, includ
bilities, was $43,317.60, and resulted in the building
The channel through the north spit was opened i
struction of about 1,000 feet of temporary jetty, a
channel was completely filled up and the jetty ac
sand and drift. The new channel, when well ope
7 feet at low water over the bar. During 1884 so
jetty was destroyed by drift, and the adjacent fill
that a portion of the outflow escaped uselessly to
rocks, causing a shoaling up of the channel over t
5 feet. In 1885 the jetty was repaired and extend
1,523 feet, giving a channel depth of about 6 feet a

WORK DONE DURING THE YEAR ENDING J

During the year ending June 30, 1888, an exten
made to the jetty pile work, in which 14,235 linea
used, and 3,384 cubic yards of stone were quarrie
jetty as filling to the pile work and as riprap o
Other operations consisted simply in the storage a
and in keeping vessel records. Capt. R. S. Little
cal charge of the work, reports:

The operations—May to September, 1887—for continua
at entrance to Coquille River covered expenditure of the bala
propriation ($20,000) made August 5, 1886, under which 403 f
seaward was made under the plan of high, close piling, appr
into the sea last made in 1884. The channel out to the ba
crossed, by a sharp turn to the south, the alignment of the j
the work, the same as it did in 1883–'84–'85. The extension o
crossed, and by accretion forming with advancement of said
existing channel, forcing it for a time to a straight course to
better one, both for the entrance and departure of vessels. I
forming were immediately noticeable as the piling was pus
extension only that, due to advancement nearer the bar and
were less marked and rapid; but before the close of operatio
southerly was cut off, it resuming a straightout course over
jetty and parallel to the jetty alignment, which course it sho
permanent works as best for navigation.

The extension was made 1½ to 2 feet wider than that of 18
7½ and 8 feet apart outside, instead of 6 feet, giving more sp

filling; and the piles used were longer and larger, general length 35 feet, with diameter at small ends of 12 inches instead of 10 inches, as before, to make stronger work according to increased exposure to seas. The piles penetrated into the sea-bed about the same, 9 to 14 feet, reinforced rapidly by the accretion mentioned.

Piles and timber were furnished by contract. All labor driving piles, framing timber, and quarrying stone was hired. A new engine and boiler for the pile-driver were purchased and fitted on driver in lieu of hiring such machinery as heretofore. The pile-driver had been taken apart and stored at close of operations, 1884-'85, and the first thing to do was to set it up, adjust the machinery, etc. New and heavier wheels and axles were put on.

Driving of piles was commenced June 15 and ended August 13, but early there were delays to pile-driving by reason of failure on part of the contractor, Marshall, to furnish piles according to the terms of his agreement, and time was lost changing to the next lowest bidder, Hunt, and some further time was lost also before the latter could get under way to deliver piles as fast as really needed to keep the driver steadily at work, which was faster than the letter of agreement (same agreement as with Marshall). Deducting delays and counting time actually worked with the driver, the average advance made with the piling was 10 feet per day.

A strong bulkhead of three cross-rows of piles was made at the sea end of the jetty to resist the seas and drift. The time engaged upon this work is exclusive of the 10 feet daily average advance.

The detail of working, in driving the two rows of piles, was as follows: The pile-driver is mounted on two trucks, four-wheeled, connected together by a frame platform, through which a king-bolt passes in frame of truck aft, and on which platform, aft part, the boiler and engine rest on raised timbers, under the ends of which move or play the side timbers of another platform to work from, carrying the gins, which platform is held in place and moved side to side of forward end, 1.4 feet from center line, on a pivotal king-pin passing through upper platform cross-timbers, the platform underneath, and the fore truck. The appliance for throwing over or moving the gins from center to sides the desired distance is a slotted bar adjustable to a pin in center of upper movable platform aft of the boiler, the bar at bottom end giving the necessary leverage on pin in working by insertion, successively, in holes in a curved bar of light railroad iron on its flat, fastened to lower or stationary platform.

The overhang, or reach, forward of the upper platform is 14 feet, allowing each time, that length of extension in driving piles. In practice four piles were driven on either row, at start, commencing at extreme reach and driving toward completed work, when the driver was moved back a couple of feet or so and the gins swung to the other side and driver moved forward, also to extreme reach, driving this row back to connection with completed work. Meantime the pile cutters-off (two men) spike on across the piles at end soon as driven 2-inch by 4-inch piece for support for light plank platform on which to stand in sawing, and commence and follow up, cutting the piles of the row that the driver is engaged upon, keeping pace with the driving as nearly as may be, and passing to the other row at end, when last pile is cut, thus permitting the shifting of driver to the unfinished row. At times, on account of interruption to work of sawing by rough seas of a high tide, the men are helped in cutting off by crew of the driver. When all the piles are cut off to grade, side cap timbers, the ties, track stringer pieces, and iron for the track are passed successively from a tender car over the platform of driver, put in place, and fastened; and the driver is then ready to proceed with another extension, as before. It required 18 to 20 piles, according to diameters, for 14 feet extension, not including the cross-piles, generally four, driven inside each 50 feet length of the piling, forming compartments. Piles, usually one at a time, were brought on a truck car to rear of the driver; a line from winch-head (the latter revolving with engine drum), passing through a single block strapped at top to sides of pins, was fastened to the pile previous to dumping same overboard. When the pile is hoisted so that its head rises a little above the platform of driver, forward end, the pile line is there hooked into a chain, then placed around the pile and same hoisted, adjusted to position, and dropped—the pile being accurately placed by moving the driver backward or forward and by moving the platform transversely as described. No interruption to the pile-driving was allowed to occur on account of rough seas during high tides, though an extra line around the foot of a pile was then found necessary. At such times, with surf rolling in, the handling of the piles required greater caution, however. The continuance of work throughout such times was due solely to the skill and energy of Charles E. Getty, pile-driver foreman, and of a very efficient crew. The entire work from the start was over the water; and the exposure to cold northwest winds, which were usually continuous, was extreme. As pile-driving progressed stone was dumped in interior spaces, following the driver closely with a thin layer, all tending to catch accretion, sand and gravel, and to check the mentioned southerly set of the ebb current. The gravel and sand was moved in from the outside, particularly from ahead of work, by flood tides. The stone used was of such size, and smaller, as one man would readily lift

on to a car, though a portion was coarser for this interior filling. A heavy dump of stone of size of a yard and under, was made on north side, at end; also a lighter dump, large stone, on south side at end. One yard of large-size stone to each foot-length of piling was dumped as riprap the length of the extension on north side, with half yard each foot-length deposited on same side for 400 feet of the 1884 work, seas having cut down, since commencement of new work, the high bank deposit along old work. On south side the high bank deposit made as the extension was pushed out, the low-water beach line nearly keeping pace.

A high dump of large-sized stone was also made at inshore end of the 1884 work, with a view to check the action of the "panning" down to low water of the high bank deposit on the north side, which action had commenced from near sea end (75 feet in) of old work, almost at beginning of the extension made.

The 1884 work was also mainly refilled with stones, the wash of the sea from north side cutting a deposit of sand and gravel therein overlying the original stone filling. Waves in entering the harbor at their southerly ends were retarded by the work as it advanced, it having effect to cant them so that their force was expended upon the deposit on north side of old work, the redeposit from which, doubtless, made the shoal water in channel along work and inside the bar, prevailing during the progress of work and fall of 1887. I account the cost of piling, new work, as filled, $15 per linear foot, and riprapping same, as described, inclusive of the amount of large stone dumped to both sides at end, $1.78 per foot additional, making $16.78 total cost. Small stone delivered inside work, at $1 per yard, and the large stone for riprap $1.78 delivered. At time of the suspension of work the outer end compartment was filled with stone to top, also 90 feet length at inner end, the section between to height of 5 feet below top, and all the 1884 work was left filled to height of the tramway. Stone in the piling has since settled considerably, probably some washed out, and the seas of a high storm last December flattened down to near low water the high dump (small stone mainly) that was of even height with the track for 100 feet length inshore from inner end of 1884 work, which rock dump had remained intact during winter of 1886–'87; and the riprap north side along both old and new work has settled 2 to 3 feet, though in sight yet, throughout, at extreme low water. The stone not scattered (referring to riprap), but in place, as dumped.

A depth of 6 feet at low water over the bar has been maintained throughout most of the year, and the shifting of the position of the channel has been less noticeable than hitherto.

FUTURE OPERATIONS.

The jetty thus far constructed is temporary in character and will need to be strengthened throughout most of its length. To obtain a needed 8-foot channel at low water over the bar, the present jetty will have to be extended, and probably a jetty on the north side of the entrance will have to be added.

APPROPRIATIONS.

Act July 14, 1880	$10,000
Act August 5, 1882	10,000
Act July 5, 1884	10,000
Act August 5, 1886	20,000
Total	50,000

Money statement.

July 1, 1887, amount available		$6,682.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,119.50	
July 1, 1888, outstanding liabilities	73.33	
		6,192.83
July 1, 1888, balance available		489.57
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,489.57

Amount (estimated) required for completion of existing project	$89,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The mouth of the Coquille River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the port of entry. The nearest light-house is on Cape Arago, 12 miles northward. The principal industry of the valley is lumbering; the timber is a good quality of fir, white cedar, spruce, ash, and myrtle. A fleet of schooners carries the product to San Francisco, and brings back supplies. There is some vessel-building on the river. The upper part of the valley is agricultural. The dairy and grazing region, half way south to Port Orford, finds an outlet at the mouth of the Coquille. Coasters ascend to Coquille City, 28 miles, and the river is navigated by light-draught vessels 12 miles further up.

The following information is obtained from statements furnished by Mr. John Flanagan, collector of customs, and by Captain Parker, Parkersburgh, applicable to the year ending June 30, 1888: Number of vessels arrived, 72; number of vessels cleared; 70. During the year one vessel was built, the registered tonnage of which is 85.64 tons.

Articles.	Quantity.	Value.
Exports:		
Lumber ..... feet, B. M..	10,500,000	$370,000.00
Hops, wheat, oats, salmon, leather, and hides ..... tons..	400	
Imports, general merchandise and machinery ..... tons..	2,847	180,000.00

The draught of vessels trading to Coquille is, when loaded, from 7 to 9 feet.

No foreign vessels have been entered, nor have any duties been collected, at the port during the year.

R R 2.

IMPROVEMENT OF THE ENTRANCE TO COOS BAY, OREGON.

DESCRIPTION OF ORIGINAL CONDITION.

The mean rise of tide above the plane of reference is 5.6 feet. The obstructions which existed at the entrance to this harbor before the works of improvement were begun consisted, first, of the outer bar, which is of sand and is shifting in character, and secondly, of the inner shoals formed by the sands which accumulate in the spring, summer, and autumn, during the times when the northwesterly winds prevail. Under the action of these winds the spit on the north side advanced toward the south, contracting the navigable passage under Coos Head to a very narrow width, and usually making the outer channel follow the west side of the spit in a long and tortuous course across the bar. The channel had at times broken through the north spit on a line, the general direction of which is from Fossil Point to a point just to the north of Coos Head. It was then direct, the depth of water was greatest, and vessels could enter or go out without trouble.

For a fuller statement of the condition of the entrance before improvement see Annual Report Chief of Engineers, 1886, pages 1990 and 1995.

PLAN OF IMPROVEMENT.

The project for this improvement, adopted in 1879, is to construct, at an estimated cost of $600,000, a jetty of wood and stone, or of stone, as may be found best, from a point 250 yards below the northern extremity of Fossil Point, on a line towards the east end of Coos Head, this line in plan, curving so as to be directed at its outer end to the head, or a little to the north of it.

The object is to prevent accretion to the south end of the sand-spit on the north side of the entrance, and to open and maintain a deeper and more direct channel across the outer bar.

AMOUNT EXPENDED AND RESULTS OBTAINED TO JUNE 30, 1887.

The amount expended to June 30, 1887, including outstanding liabilities, was $132,839.58. The jetty had then been partly built to a length of 1,761 feet. The first section, 650 feet in length, consists of timber cribs filled with stone; the next section, 695 feet in length, consists of box-cribs and a stone dump; the last section, 416 feet in length, consists of a stone dump simply.

Starting from about the high-tide line at the inner end, the top of the jetty inclines to low water at a distance of 700 feet; then for a distance of 645 feet it is nearly level, averaging a height of about 2 feet below low water; then it inclines again for a distance of 416 feet, till its depth below low water is 13 feet.

The jetty had caused a partial erosion of the end of the north spit and had opened a channel well to the south which was deeper, wider, and less exposed to wind and sea than the former channel in its usual position. The new channel is also much less shifting than the old one.

WORK DONE DURING THE YEAR ENDING JUNE 30, 1888.

No active operations in jetty building were conducted. Vessel records were kept and a watchman was employed to look after the Government property. A supply of water being available for quarry sluicing during the rainy season the watchman, with a little assistance, succeeded in washing into the bay about 7,000 cubic yards of dirt overlying the ledge at the Fossil Point quarry.

A recommendation from the officer in charge that the balance of the funds available at the beginning of the year, less $6,000 for engineering, inspection, superintendence, and care of property, be applied in placing a foundation-course of stone in advance of the present jetty for a length of 400 feet, a width of 50 feet, and a thickness varying from 5 to 10 feet and that the work be done by contract, was approved July 13. Bids were invited for this work by advertising in San Francisco, Portland, and Marshfield papers, by posting printed advertisements and specifications in public places in Portland and Coos Bay, and by sending specifications to such parties as would most probably wish to undertake the work. No bids were received, however, and for the reason, it is thought, that the amount to be expended was too small to induce parties to enter into contract. For a like reason it was not deemed judicious to undertake the work with hired labor, so the Chief of Engineers recommended that the funds available be held to await the further action of Congress, which recommendation was duly approved by the Secretary of War October 12, 1887.

There has been no change of importance in the channel during the

year. Both the depth and position have varied somewhat with the season, as is usual, but the general condition of the entrance has remained about the same as during the preceding years.

FUTURE OPERATIONS.

It is expected that the jetty will be extended about 600 feet and that its top throughout will be raised to 2 feet above low water. The first work to be done after sufficient funds become available to resume operations will be to lay a proper foundation-course of stone on the line of the proposed extension. This will be needed to prevent the bottom from scouring out and so to keep the cross-section of the jetty as small as possible.

The average depth of water over the 600 feet of proposed extension is about 60 feet, so that a large part of the stone needed for the extension can be dumped from scows, if this should prove a more economical method than by the use of tramway and cars. Stone for completing the present jetty and for topping out any extension that may be made will have to be taken by cars on a tramway.

APPROPRIATIONS.

Act of March 3, 1879	$40,000
Act of March 3, 1881	30,000
Act of August 2, 1882	30,000
Act of July 5, 1884	30,000
Act of August 5, 1886	33,750
Total	163,750

Money statement.

July 1, 1887, amount available		$30,910.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,433.03	
July 1, 1888, outstanding liabilities	256.49	
		1,689.52
July 1, 1888, balance available		29,220.90
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		79,220.90

Amount (estimated) required for completion of existing project	386,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Coos Bay is in the collection district of Southern Oregon. Empire City, on the bay, is the port of entry. The nearest light-house is at Cape Arago, on the south side and west of the entrance.

The following returns, furnished by Mr. John Flanagan, collector of customs, Coos Bay, are for the year ending June 30, 1888:

Value of domestic imports		$198,780
Value of domestic exports		580,500
Number of vessels arrived coastwise		117
Number of vessels cleared coastwise		116
Registered tonnage of vessels arrived coastwise	tons..	32,403.48
Registered tonnage of vessels cleared coastwise	tons..	31,677.77
Number of vessels built during the year		
Registered tonnage of vessel built during the year	tons..	737.86

The draught of the vessels trading to Coos Bay, when loaded, varies from 13 feet to 14 feet 10 inches.

The principal exports are lumber and coal; hops, wheat, oats, salmon, leather, and hides are also among the exports.

The imports consist of general merchandise and machinery.

No foreign vessels have been entered nor have any duties been collected at this port during the year.

R R 3.

IMPROVEMENT OF UMPQUA RIVER, OREGON.

DESCRIPTION OF ORIGINAL CONDITION.

Just below Scottsburgh, the head of navigation on the Umpqua River, are five sandstone bars or ledges, 12 feet to 15 feet wide and submerged from 1 foot to 2 feet at low tide on a low-river stage. They are separated by pools about 150 feet wide and from 5 to 10 feet deep at low water.

PLAN OF IMPROVEMENT.

The honorable Secretary of War having authorized the expenditure of the balance remaining of the appropriation of March 3, 1871, viz, $4,685.89, in improving the river below Scottsburgh, a project was submitted and approved in 1885, for making, at an estimated cost of $4,056, a channel 50 feet wide and 3 feet deep at low water through the rock-ledges above described by drilling and blasting the rock and removing the broken pieces to deeper water in the pools.

AMOUNT EXPENDED AND RESULTS OBTAINED TO JUNE 30, 1887.

The amount expended on the project to June 30, 1887, including outstanding liabilities, was $4,715.51, and resulted in increasing the controlling depths over the reefs, through a channel 50 feet wide, from 1 foot at low water, which formerly existed, to 2 feet at low water.

WORK DONE DURING THE YEAR ENDING JUNE 30, 1888.

No work whatever was done during the past year for want of funds. There has been no change in the channel since June 30, 1887.

FUTURE OPERATIONS.

It was estimated, at the time work was suspended, that $2,000 would be required to complete the present project. This amount could be profitably expended in one season.

REMARKS.

In compliance with the act of August 5, 1886, a preliminary examination of the Umpqua River was made, and in the report of this examination (page 2500, Annual Report Chief of Engineers 1887) it was estimated that $30,000 would be required to give a needed channel of 4 feet depth at low water from Gardiner to Scottsburgh.

APPROPRIATION.

Act March 3, 1871, Umpqua River, Oregon	$22,500

Money statement.

July 1, 1887, amount on hand		$14.04
Amount received by transfer of property to other appropriations		63.86
		77.90
July 1, 1888, amount expended during fiscal year, inclusive of liabilities outstanding July 1, 1887	$41.19	
July 1, 1888, outstanding liabilities	25.96	
		67.15
July 1, 1888, balance available		10.75
Amount appropriated by act of August 11, 1888		2,000.00
Amount available for fiscal year ending June 30, 1889		2,010.75

COMMERCIAL STATISTICS.

Umpqua River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the nearest port of entry. The nearest light-house is at Cape Arago, entrance to Coos Bay, distant 22 miles.

The river below Scottsburgh is a part of a tri-weekly mail-route from Drains, on the Oregon and California Railroad, to the lower river district, and to the Lower Siuslaw and to the Coos Bay region. The distance by wagon-road from Drains to Scottsburgh is 30 miles, while the distance from the railroad to navigable waters on the mail-routes next north and south of the Umpqua route is about 60 miles.

For five years at least the mail-boat on the Umpqua has been a small tug which draws 4 feet, carries passengers and express, and tows a scow for carrying freight. The tug is more economical than a stern-wheel boat would be, and is better adapted for service near the mouth of the river, where there are two mail landings. There is another steam craft working on the lower river and generally used in towing logs. A bar-tug is stationed at Gardiner, near the river mouth, which has, however, no special cause for going above.

There is a tannery at Scottsburgh whose product is shipped to San Francisco. Farm products are also taken down the river to supply the logging camps and Gardiner, where there is a large saw-mill, which maintains a lumber trade, by vessel, to San Francisco.

The following returns, furnished by Mr. William R. M'Kenzie, Gardiner, Oregon, are for the year ending June 30, 1888:

Number of vessels entered harbor	41
Number of vessels cleared harbor	41

The cargo capacity of these vessels, lumber laden, is from 250,000 feet to 720,000 feet, B. M. Their draught, when loaded, ranges from 13 feet to 14 feet 10 inches.

The schooners usually sail in, but are towed out by steam-tugs.

IMPORTS.

The imports consisted of general merchandise, machinery, and cannery supplies, amounting to about	tons..	1,700
And valued, approximately, at		$150,000

EXPORTS.

		Value.
Hops	20 tons..	*$5,000
Wheat and oats	300 tons..	*7,000
Salmon	9,000 cases..	*45,000
Salmon	250 bbls..	*1,750
Lumber	12,315,000 feet, B. M..	184,725
Laths	4,361,000, number..	10,902
Leather	6 tons..	3,600
Hides and furs		*1,500
Total value of exports		259,477

No foreign vessels have been entered nor have any duties been collected at the port during the year.

* Approximate.

R R 4.

IMPROVEMENT OF THE ENTRANCE TO YAQUINA BAY, OREGON.

DESCRIPTION OF ORIGINAL CONDITION.

The mean rise of tide is 7.1 feet.

The usual prevailing depths over the bar at low water before improvement, were from 7 feet to 8 feet. Three distinct channels existed, known as the north, middle, and south channels. The south channel was the one most used, but was rendered dangerous by the presence of rocks. The middle channel, though free from rocks, was usually the shoalest of the three, and so was little used. The north channel, besides being long and tortuous, was so studded with rocks as to be considered unnavigable. Owing to the shifting nature of the bar, these channels were constantly changing both in position and in depth.

PLAN OF IMPROVEMENT.

The approved project, adopted in 1881, is to run out a dike or jetty on the south side of the entrance so as to cause the south channel to shoal to and the flow to be deflected northward, with a view to opening and maintaining the central channel, with a least depth of 17 feet at high water.

As originally projected, the dike was to start from near low-water line and run out into the sea a distance of 2,500 feet, and was to rise to 2 feet above mean low water. The beach on the line of the jetty, from high-water level to low-water level, was to be protected by sinking gabions in the beach with sand heaped over them, and by covering the surface with a layer of mattresses and stone.

The stone for the jetty was to be deposited in place from barges; and cribs were to be used, if practicable. It was found, however, that cribs could not be used on account of the strong currents and high seas, and that the ocean swell, even in quiet weather, was too great to permit the use of stone barges. Accordingly, the jetty had to be built from the shore end, by carrying the stone out over a tramway, and was begun at high-tide line instead of at low-tide line, thus making the total projected length of the jetty, in 1881, 3,700 feet. In 1884 the jetty was extended shoreward a distance of 316 feet, making the present total projected length of the jetty about 4,000 feet.

AMOUNT EXPENDED AND RESULTS OBTAINED TO JUNE 30, 1887.

The amount expended to June 30, 1887, including outstanding liabilities, was $192,523.16. At that date, 2,517 feet of jetty and 450 feet of dike had been constructed, but not completed to full height and strength.

The south channel had been permanently deflected from the south rocks, and for a part of the time made to unite with the central channel. The prevailing depths over the bar were greater by 2 or 3 feet, and the channel was less shifting and much safer than formerly.

WORK DONE DURING THE YEAR ENDING JUNE 30, 1888.

It was thought that the funds available at the beginning of the year would permit an extension of 600 feet to be made to the jetty during the year. However, such a scouring took place around the head of the

jetty as it advanced as to necessitate using much more stone than was estimated for. On this account an extension of only 460 feet was made.

Mr. J. S. Polhemus, assistant engineer, in local charge at Yaquina Bay, reports:

At the close of the last fiscal year all the surveys and preliminary work were finished. The scows had been thoroughly overhauled and repaired, the wharf and jetty tramway strengthened and made strong enough to support the new 5-ton locomotive, which was to replace mules as a motive power in hauling the stone and other materials.

Twenty dump cars had been constructed with the new iron-work purchased from the East.

Twenty-five tons of new steel rails (25 pounds to the yard) had been laid on the tramway, with the necessary switches, turn-outs, etc. The working plant was all in order, and the work of jetty extension actually begun.

In a general way, the work accomplished was the extension of the jetty 460 feet and the strengthening of the old part of the jetty by riprapping it with stone along its north side.

JETTY TRAMWAY EXTENSION.

A new revolving pile-driver had been constructed earlier in the season. A frame supporting the "gins," hoisting-engine, hammer, etc., was made to revolve on a track on a platform resting on four ordinary diamond trucks.

The engine acted as a counterpoise to the hammer and piles, and the gins extended out over 20 feet beyond the forward truck wheels, so that piles could be driven 20 feet in advance of the completed track.

A No. 6 Blake pump was rigged on the driver; a 3-inch suction hose led to the water beneath, and a jet of water was forced through a 1½-inch iron pipe, placed alongside the piles, to assist in driving them through the sandy material.

The tramway consisted of bents of four piles each, 10 feet apart, capped with pieces 10 inches by 12 inches by 18 feet, on top of which were bolted four stringers 9 inches by 12 inches by 25 feet, which supported the T iron track rails.

The piles were pumped down into the sandy bottom from 10 to 15 feet. Two bents were driven at a time, then capped, and the track extended. The hammer and jet were both necessary to get the piles down, as, generally, several strata of coarse gravel were encountered.

The depth of the water at the end of the old jetty where the work commenced, was about 15 feet at mean low water, and where it ended for the season, 460 feet in advance, about 22 feet.

This work was all done in the face of a heavy sea, and it was very difficult to hold the piles in position.

The latter part of the ebb tide is the most favorable time for this work.

The tramway extension was finished in October.

BRUSH-MATTRESS WORK.

As soon as about 100 feet of tramway was completed, the bottom around the piles was covered with a brush-mattress 40 feet wide and 24 inches thick, built in sections 20 feet at a time on a grillage of poles under the track, the whole being weighted with stone and lowered into place when completed.

The mattresses were made of fascines of pine brush about 1 foot in diameter and 20 feet long, all stoutly tied together with 1½-inch rope.

All of this work was done by hired labor, the brush being cut and bound in the neighboring pine thickets and hauled to the track. About 300 cords of brush fascines were used in the 460 feet of jetty extension.

STONE SUPPLY.

A contract had been entered into with Mr. Ralph Ingham earlier in the season to deliver on board Government scows at the Cannon Quarry, 14 miles up the river, 650 tons of stone per week, averaging in weight 2,000 pounds to the piece, at 48 cents per ton. He commenced to deliver stone June 23, 1887, but shortly afterward, becoming embarrassed, he left the country, and his bondsmen were compelled to continue the contract. They did not furnish stone, however, as fast as called for by the specifications, much to the disadvantage of the jetty work, and in November we commenced to strip and open up a new quarry by hired labor, situated half a mile below the old quarry on the river.

We procured from this source 4,320 tons, and left the quarry in good shape for another season.

We received from the contractors 15,986 tons, making a total of stone used 20,306 net tons.

The stone was of very good quality, and the pieces averaged 2,000 pounds in weight, the largest blocks weighing over 6,000 pounds.

The measurement of the stone was ascertained by scow displacement. The scows having been previously carefully measured and graduated, their draught loaded and light was noted each trip, and the cubic displacement multipled by 64½ pounds, the weight of a cubic foot of salt water, for the tonnage.

At South Beach the stone was hoisted from the deck of the scows to the cars on the wharf by a small engine and derrick the larger pieces being taken direct with chain hooks and the smaller ones in boxes.

Trains of ten cars, being loaded, were hauled out on the jetty by the locomotive and dumped on the jetty by two brakemen, while another train was being made up on the wharf.

The last stone was received March 10.

Of the total stone used, 10,520 tons were dumped on the 460 feet extension, and the balánce off the north track of the old jetty, to strengthen and protect it.

As this work was prolonged throughout the winter, many interruptions were occasioned by heavy gales and rain,

At times of severe storms it is impossible to work on the tramway, as the seas break entirely over it.

It would be a great advantage if the appropriations were available to be used in the early spring and summer.

March 15, 1888, the appropriation being nearly exhausted, the plant and Government property were all stored away and left in charge of a watchman and the force disbanded.

In the latter part of March, the force of the sea at the inner end of the jetty and along the protecting spur began to increase.

Soon the low-water line receded shoreward until it reached the outer edge of the spur work. This soon became undermined and badly damaged; the seas swept over it with great force as the high tides of spring and early summer came on, and rapidly cut the sand-bank behind it away.

In the latter part of May, after a strip over 100 feet in width had been washed away, 3,000 bags were purchased and filled with sand, and placed with brush as a revetment against the face of the bank. For a time this served as a protection to the bank and prevented further washing. The very high tides in June, however, damaged the bulkhead of bags, and the sea washed over them and commenced to cut away the bank again.

A strip 1,000 feet long and 200 feet wide has gone, and 600 feet of the shore tramway, from the inner end of the jetty, has been lost. The rails and all valuable materials have been saved.

The sea is still encroaching, although at a much slower rate, and is within 60 feet of the principal store-house.

The jetty itself remains intact, not a pile having been displaced. The last survey I made of the bar, until recently, was made early in July, 1887, and showed the best depth of water in the Bar Channel yet found, viz, 13 feet at mean low tide, with the channel to the north of the jetty range.

The condition of the bar continued good throughout the summer and autumn until November, the channel going out straight and generally crossing the jetty range slightly to the south, at the outer edge of the bar; the least depths in channel on the bar varied from 12 to 10 feet at mean low water. In November, after the storms commenced, sand accumulated on the bar, and its channel depth was reduced from 1 to 2 feet, the range of the channel going to the north of the line of jetty.

During January and February, 1888, the condition of the bar was at its worst. The heavy seas of winter reduced its least channel depth to about 8 feet early in February, and the channel was to the north of the jetty range and not very well defined. After February it began to improve, and the channel soon showed 10 feet at mean low water, which depth it has maintained until the present with some improvement, as shown by the late examination.

The late examination above referred to was made June 9, 1888, when the channel was found to have a depth of 11 feet at low water, and to be straight out on a line a little to the north of but parallel to the jetty.

FUTURE OPERATIONS.

The part of the jetty already constructed needs raising and strengthening. An extension shoreward of 600 feet or more will be needed to

close the breach in the jetty tramway recently started and now widening at the shore end of the jetty.

A spur-dike for shore protection will also be needed.

If the present project is carried out, an extension seaward of about 1,500 feet will have to be made.

A project was submitted by Capt. Chas. F. Powell, Corps of Engineers, on April 6, 1887 (page 2467, Annual Report Chief of Engineers, 1887), for a jetty on the north side of the entrance. This jetty would close the north channel, through which, at certain times of the year, a large part of the tidal waters pass, and would, with the south jetty, tend to concentrate the tidal currents in one central channel, and thus insure the deepest water practicable over the bar. No notice has been received of the approval of this project, though Department instructions by telegraph of late date direct that the estimates in this report provide for a north jetty.

Such an improvement to the entrance as will permit foreign grain ships to cross out, when loaded, is most urgently demanded. A vigorous prosecution of the work of improvement would not interfere with navigation; and for the sake of economy it is desirable that the work should progress rapidly. The whole amount asked for could be profitably expended in one year.

APPROPRIATIONS.

Act June 14, 1880	$40,000
Act March 3, 1881	10,000
Act August 2, 1882	60,000
Act July 5, 1884	50,000
Act August 5, 1886	75,000
Total	235,000

Money statement.

July 1, 1887, amount available		$42,476.84
Amount refunded on account of errors in freight charges		20.55
		42,497.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$41,674.98	
July 1, 1888, outstanding liabilities	155.50	
		41,830.48
July 1, 1888, balance available		666.91
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		150,666.91

Amount (estimated) required for completion of existing project	317,332.91
Amount that can be profitably expended in fiscal year ending June 30, 1890	250,000.00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Yaquina Bay is in the collection district of Yaquina. Yaquina is the port of entry. The nearest light-house is at Cape Foulweather, 4¼ miles north of the entrance. Yaquina Bay forms, with the Oregon Pacific Railroad, a competitive line from the Willamette Valley to San Francisco. A coasting steam schooner runs to and from the bay. A new shipping company has recently been incorporated, with the object of developing a trade with Portland and the intermediate ports along the coast.

The following returns, furnished by Mr. John Priest, collector of customs, Yaquina, are for the year ending June 30, 1888:

Revenue from customs		$25,437.82
Value of imports		$32,920.57
Number of vessels cleared		61
Their tonnage	tons..	34,872.25
Number of vessels entered		63
Their tonnage	tons..	34,964.16
Probable number of arrivals and departures of vessels which do not enter and clear		20

The chief articles of commerce are grain and merchandise.

The value of the exports for the year is not stated.

During the year, 7 vessels having dutiable merchandise on board entered the port, and none cleared.

The registered tonnage of the port is:

Incoming	tons..	33,521.86
Outgoing	do...	33,164.07

RR 5.

PRELIMINARY EXAMINATION OF TILLAMOOK BAY AND BAR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, January 29, 1887.

SIR: I have the honor to transmit herewith an extract of a report by Lieut. Edward Burr, Corps of Engineers, of a preliminary examination of Tillamook Bay and Bar, Oregon, required by Department letter for compliance with the river and harbor act of August 5, 1886.

Tillamook is the principal place of the region; it is on a small slough near the head of the bay, and is the distributing and receiving point of a fertile and rapidly settling country along three rivers and numerous sloughs; the coast trails and roads also converge here.

Cannery and lumber-mill sites on the lower bay are reached by sufficiently good channels, for medium sized coasters, over the bar and above; but no wagon-roads lead to these places from the interior and none are reasonably practicable. Between these places and Tillamook is a shoal in the bay channel and a bar and sunken drift in the slough, which prevent all but the smallest coasters, and then at high tide, from going to Tillamook. Consequently, the lumber vessels enter mostly in ballast, or freight carried by them to and from Tillamook must be reshipped. The best timber of the bay region is judged to be up the rivers, and that it would be for the interests of commerce to render mill-sites available near the better log supply and where the *teredo* is less destructive.

I therefore report that Tillamook Bay is worthy of improvement, and that $1,500 are required for a survey for preparing plans for deepening the channel to Tillamook and for works to prevent the shoals from reforming.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 24, 1886.

SIR: I have the honor to submit the following report of an examination of Tillamook Bay and Bar, made in accordance with your instructions.

Tillamook Bay is situated on the northwestern coast of Oregon, with its entrance about 45 miles south of the entrance to the Columbia River. The entrance to the bay is about 2,000 feet wide, and lies between a high rocky point on the north and a low sand point on the south. This sand point makes to the north from Cape Mears and separates Tillamook Bay for a greater part of its length from the ocean. It is of low sand-hills covered with brush excepting about a mile of its northern end, and this part is a low sand-spit.

The bar lies to the seaward of this entrance, is of the sand formation usual on this coast, and without reefs. There is one small reef just within the entrance. The channel is straight and varies but little in position, having moved but slightly since the Coast Survey examination of 1867. It has probably a depth at mean high water of 16 or 18 feet, a depth ample for present needs. The bay is frequented by small coasters drawing from 7 to 10 feet and by lumber vessels drawing 12 and 13 feet. There seems to be no complaint about the bar channel, excepting with regard to the Fairway buoy. The bay has a length of about 6 miles and a greatest width of nearly 8½ miles. The general depth of water is small and there are many flats bare at low water. Several channels extend to the head of the bay, but they are somewhat tortuous and have only a small depth of water. The flats and channels have both changed slightly in position since the Coast Survey examination of 1867, the only survey known to have been made of the bay and its entrance. In the lower part of the bay the bottom is of hard sand but in the upper bay it is of mud and the flats are covered with eel-grass. The changes in the latter are said to be less than in the former.

The three principal tributaries, the Wilson, Trask, and Tillamook rivers, enter the bay at its head through a number of sloughs, producing conflicting currents with consequent flats and small, shallow channels.

Tillamook, the county seat and the principal distributing point for that section of the coast, is situated on a small slough between the Trask and Wilson rivers, and is 2½ miles from the head of the bay. This slough, known as Hoquarton Slough, is very crooked and has a width of about 50 feet at Tillamook. This width increases towards the bay from additions from the Wilson and Trask rivers. Vessels drawing 7 feet ascend to the town by taking advantage of the tide. The obstructions are a bar, called Dry Stocking Bar, across the mouth of the slough, and some sunken drift on the bottom of the slough a short distance below Tillamook. At mean low water there are only about 18 inches of water over the former, and only about 3 feet over the latter. The town people desire an increased depth of water at these places so as to allow vessels a readier access to the town. It is also desired to have the channels in the bay marked either by buoys or by pile-beacons, preferably the latter. The *teredo* is very destructive in the bay.

There are four settlements on the bay, each having a post-office. Mails are brought three times a week by the wagon road from North Yamhill, and once a week by the trail from Astoria. All freights are carried in or out by coasters, and these vessels have no trouble in visiting the bay except during stormy winter weather. The principal industry is the salmon fishing. The fall run of salmon is very plentiful. There are two canneries on the bay, and the pack for the season of 1886 was between 30,000 and 35,000 cases.

There are large quantities of spruce, fir, and cedar timber on the streams tributary to the bay, and the winter freshets on these streams fit them for the driving of logs. Two saw-mills are in operation, one of them cutting lumber for the San Francisco market. This export of lumber was begun in the summer of 1886 and consisted of four cargoes, aggregating about 1,000,000 feet. It is reported that San Francisco parties will erect a large mill next spring to utilize the spruce timber for box purposes.

The canneries and mills are all located near the lower end of the bay, and are easy of access. There is a considerable quantity of agricultural lands tributary to the bay and used principally for stock-raising and dairy farming. Dairy products are shipped to Astoria, and cattle are driven by the beach and the trail to the same point.

The entrance to the bay requires no attention. All of the principal shipping interests on the bay are located near its entrance, and the channel allows them to be easily reached. The town of Tillamook can be reached by small coasters on their occasional visits without much trouble by taking advantage of the tide.

* * * * * * * * *

Very respectfully, your obedient servant,

EDW. BURR,
First Lieutenant of Engineers.

To Capt. C. F. POWELL,
Corps of Engineers.

SURVEY OF TILLAMOOK BAY AND BAR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, February 8, 1888.

SIR: The following report of the results of a survey of Tillamook Bay, Oregon, are submitted, with a plan and an estimate of cost of improvement, and maps of the survey in three sheets.

Guided by the results of the preliminary examination, the survey was limited to the interior waters of the bay, and more particularly to the upper part of the bay and to the slough on which Tillamook City, the principal settlement and county seat, is situated; a reduction of one-third from the estimated cost of the survey caused a curtailing of the intended work and some delay in preparing the drawings. The report of the examination was submitted January 29, 1887; attention is invited to it in connection with this survey report.

As may be seen from the map herewith, scale 1: 10,000, the bay is inclosed on the north and south by steep bluffs, on the east by vast tide lands cut by numerous water-passages, and on the west by a low sand cape. The entrance, some 2,000 feet wide, with central depths of 30 feet, is between a bluff on the north and the north end of the sand cape; the bar channel is less shifting than the natural channels at Oregon entrances to the south; its controlling depths varies at times from 10 to 15 feet; depths named are ones below mean lower low waters. The mean rise of tide above this plane is about 7 feet.

The area of the bay is about 3 miles by 6; surrounded by high wooded hills, it appears at high tide like a safe and capacious harbor. At low tide it is a vast sand and mud flat cut by three distinct channels. The north channel lies close under the north shore; it has good depth past the canneries at Garibaldi and Hobsonville and at Smith's saw mill; beyond, the channel runs out. East of Garibaldi, a narrow but fairly deep cut-off joins the north and main channels. The south channel has the deepest water at and near its junction with the main channel, but becomes narrow and shoal at its upper part, where it follows the south shore of the bay and again joins the main channel. The south channel is but little used, there being no settlements on that side of the bay. The main or middle channel extends the entire length of the bay, and connects the entrance with Tillamook River, which comes in at the southeastern part of the bay.

Tillamook River has a good channel for coasters some distance up. Wilson River, a smaller stream, flows into the bay near and north of the mouth of the Tillamook. Hoquarton Slough, which is very tortuous and somewhat obstructed, and on which the town of Tillamook is situated, lies between the two rivers and connects with Tillamook River near the mouth of the latter. Trask River, between the slough and Tillamook River, has two meandering outlets, one to each. A second map herewith, scale 1: 4800, shows these tributary waters. The rivers are mountain streams in the upper part of their course and tidal sloughs in the lower portion. The best country, grazing and farming, of the region is up these rivers and around the head of the bay; higher up the rivers are timber lands.

Tillamook River is by far the best stream for navigation, but its banks are low and overflowed for miles, affording at no place on its navigable part, it is judged, a suitable landing nor a convenient and accessible point for the trade of the settled country; neither is such a point found along the north or south channels of the bay on account of the little room at the foot of the steep bluffs there and the absence of ordinarily

practicable land routes to the settled country; besides, the *teredo* is very destructive on the lower bay. Tillamook has a good location, and it appears about the only good location, for the trade of the region. The main bay channel, one leading to Hoquarton Slough, has a controlling lower-water depth of 3 feet and wide shoals of only 5 feet depth; Dry Stocking Bar, at the mouth of the slough, carries 1 foot. The depths up the slough to Tillamook, about 3 miles, are as good as in the bay channel; the main obstacles to navigation of the slough to the town, besides its sharp bends, are snags and sunken drift.

People interested in navigation to Tillamook want the snags and drift removed, the Dry Stocking Bar channel deepened and the bay channel marked by beacons. The project of improvement recommended is based on these objects. The mean rise of tide above the plane of reference at Tillamook is 6.6 feet, so that deepening Dry Stocking Bar to 3 feet would permit vessels of 9 feet draught to go to Tillamook on mean high tide. To give a deeper channel would require dredging in the slough at the points or for cut-offs, and considerable dredging in the bay channel, for which there is no plant on or near the bay, and the cost of which work is hardly warranted by present commerce.

Dry Stocking Bar is composed of mud, sand, and coarse gravel; the material is soft and partly loose; and it is expected to scour out and hold a channel by closing with a dam two small outlets on the line A B, as shown on the map of the bar herewith, scale 1:2400. This will decrease the width of the slough at the foot of the bar to that which naturally gives a good depth, and force the flood and ebb along the same channel-way over all the bar. The bank on the opposite or left side of the channel will have to be revetted, from 04 to 0T. A grading of the bank and its covering with a foot thickness of stone is proposed. It is further intended to increase the volume of flow over the bar by removing a drift jam from the Hoquarton mouth of the Trask River, and building a dam across the Tillamook outlet of the Trask.

There are no stone quarries opened on the bay, but there is some stone scattered along the foot of the bluffs; other available materials for the dams are brush and suitable clay, which underlies the surface soil of the tide lands. The clay is the cheapest and the brush next in cost; therefore the construction is planned as shown by the drawings on the map of the bar.

The estimate of cost is for the—

Dam A B:	
2,025 cubic yards clay, at 35 cents	$708.75
766 cubic yards brush, at 63 cents	482.58
89 cubic yards stone, at $2.50	222.50
Seeding dam	5.00
Trask River Dam:	
1,222 cubic yards clay, at 35 cents	427.70
782 cubic yards brush, at 63 cents	492.66
74 cubic yards stone, at $2.50	185.00
Seeding dam	3.00
Tools and lumber for both dams	100.00
Drift, removal, Trask River	600.00
Snagging, Hoquarton Slough	400.00
Eight single-pile beacons, main channel of bay	200.00
Contractor's profit, 20 per cent	865.00
Engineering and inspection	500.00
Total	5,192.19
Annual maintenance	150.00

COMMERCIAL STATISTICS.

The shipments from Tillamook are beef, wool, dairy products and farm truck to the canneries and saw-mill. The steam-schooner *Rosa Olsen*, 50 tons burden, averages about twenty trips annually from the Columbia River to Tillamook; the freight charge is $8 per ton. The steamer *Garfield*, 20 tons, and 5.5 feet draught, generally makes daily round trips between Garibaldi and Tillamook. The steam-launch *Daphne* drawing a little over 3 feet, plies between Tillamook and points on the bay.

The coasting steamer *Tillamook*, built for the trade about a year and a half ago, carries lumber from the mill on the lower bay to San Francisco. Her capacity is 300,000 feet; she makes a round trip about once a month, bringing back mill and logging supplies.

The steamer *Field*, 60 tons burden, makes about forty trips per year between Astoria and Hobsonville, taking in cannery supplies and carrying out salmon. Other crafts occasionally carry out salmon during the season; the shipments last season from Hobsonville were 16,000 cases, and from Garibaldi 10,000 cases, valued at about $5 per case. The freight charge to the lower bay points is $6 per ton, being $2 less than to Tillamook, only from 12 to 15 miles further. A deeper channel to Tillamook would reduce the extra charge of $2.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX S S.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY; CONSTRUCTION OF CASCADES CANAL, COLUMBIA RIVER; IMPROVEMENT OF THE CHEHALIS RIVER, WASHINGTON TERRITORY; IMPROVEMENT OF THE SKAGIT, STEILAQUAMISH, NOOTSACK, SNOHOMISH, AND SNOQUALMIE RIVERS, WASHINGTON TERRITORY; WATER-GAUGES ON COLUMBIA RIVER.

REPORT OF MAJOR THOMAS H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mouth of the Columbia River, Oregon and Washington Territory.
2. Construction of canal at the Cascades, Columbia River, Oregon.
3. Chehalis River, Washington Territory.
4. Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Washington Territory.
5. Gauging waters of the Columbia River, Oregon.

EXAMINATIONS.

6. Wood River, Oregon.
7. Link River, Oregon.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, July 9, 1888.

SIR: I have the honor to submit herewith annual reports for the fiscal year ending June 30, 1888, upon the works of river improvements now in my charge.

These works were in charge of Capt. Charles F. Powell, Corps of Engineers, U. S. Army, from the beginning of the year to April, 1888.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

S S 1.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY.

The project under which this work is being carried on was adopted in 1884. It contemplates providing a channel across the Columbia River Bar, having a depth of 30 feet at mean low tide. This is to be effected by concentrating the water flowing over the bar and increasing the re-

sultant currents to such a degree as to procure the desired depth. Any work for accomplishing this end must be more or less tentative in its character. The work which is now in progress is the building of a low-tide jetty starting from Fort Stevens, on the South Cape, and extending in a westerly direction, with a slight curve to the south, out across Clatsop Spit, for a distance of 4½ miles, more or less, as circumstances may require, to a point about 3 miles south of Cape Hancock (Disappointment). This jetty is constructed of stone, resting upon a mattress foundation about 40 feet wide and from 2½ to 5 feet thick. The stone extends to the level of mean lower low water. The materials thus far have been placed in position from a jetty tramway supported upon piles driven along the line of the jetty, and about 24 feet above the level of low tide. This tramway is a double track, 3-foot gauge railroad, the tracks being 13 feet between centers. The materials are landed at the wharf and transported to place over these tracks, which are built in advance of the main work.

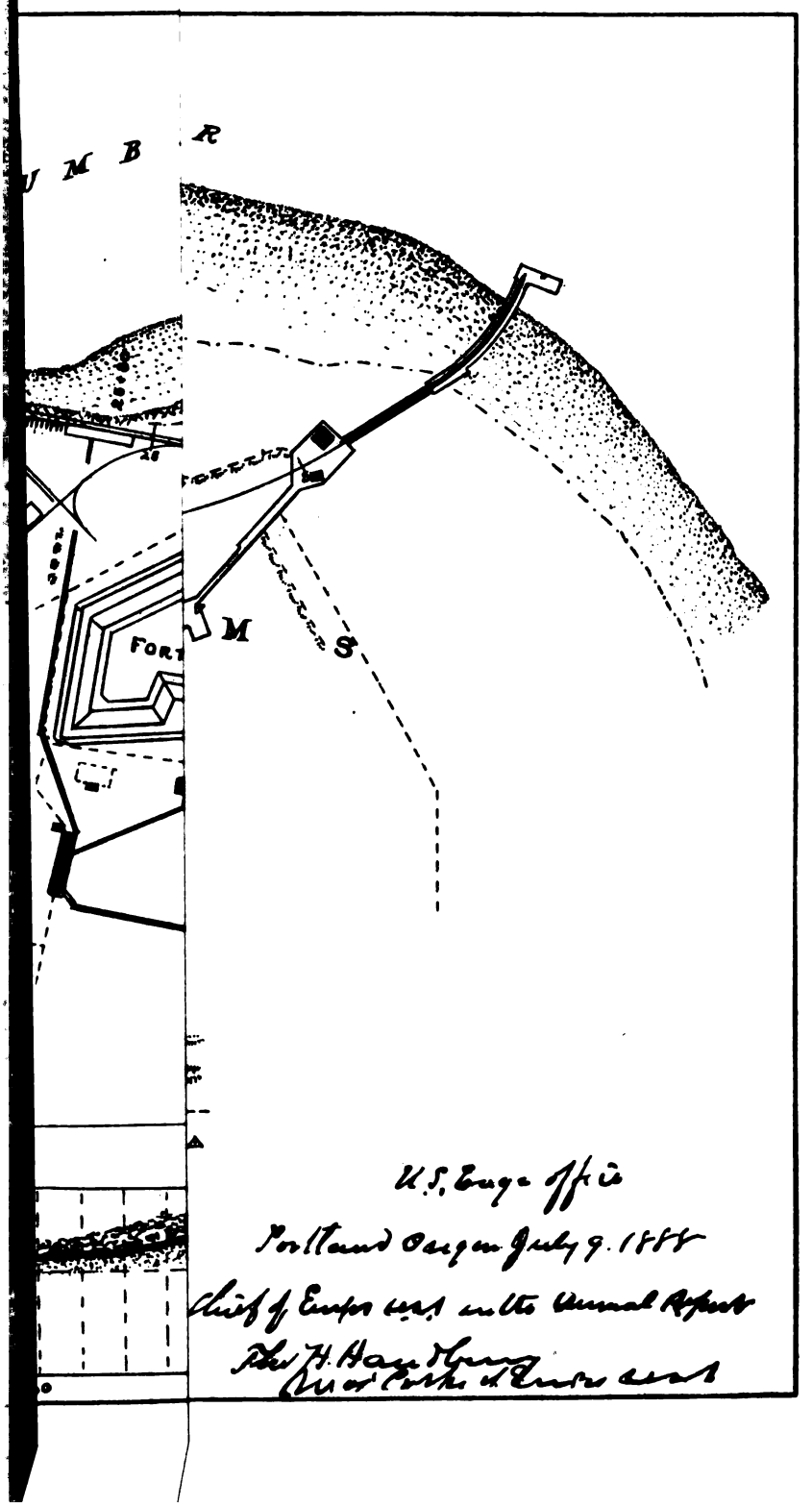
The first appropriation for work under this project was made in the river and harbor act approved July 5, 1884. There has been appropriated up to June 30, 1888, $287,500. The amount expended to that date, including outstanding liabilities, is $247,331.75, leaving an available balance on hand of $40,246.25.

The jetty proper is now under construction for a little more than one-half mile. Over much of this distance only a thin layer of stone has yet been placed. This work is not yet sufficiently advanced to show any appreciable effect upon the channel over the bar.

By virtue of paragraph 1, Special Orders, No. 60, dated Headquarters of the Army, Adjutant General's Office, Washington, D. C., March 14, 1888, I relieved Capt. Charles F. Powell, Corps of Engineers, of the charge of this work April 20, 1888.

During the fiscal year the jetty tramway was extended to Station 66 + 40, which is an addition of 2,500 feet since last Annual Report. The mattress work was pushed to Station 54 + 72, an addition of 1,400 feet. Station 25 + 80 is regarded as the root or commencement of the jetty proper. Twenty thousand three hundred and fifteen tons of stone have been used during the year. Of this amount but 3,944 tons were furnished by the Oregon Paving and Contract Company at 63½ cents per ton, delivered at Fort Stevens Wharf, on barges furnished by the Government, under their contract of June 2, 1887; 6,904 tons were purchased in open market at 80 cents per ton, and 9,468 tons at 70 cents per ton. Under date of June 2, 1887, the Oregon Paving and Contract Company contracted to deliver 1,200 piles at 8 cents per linear foot; of this number they have delivered but 481; 41,714 linear feet have been purchased in open market, on 10 days' notice for bids, at 10 cents per foot, and 4,706 feet at 8 cents per foot. The other lumber and material necessary for the construction of the jetty tramway and accessory works have been purchased generally by public notice of ten days and sealed proposals, and sometimes by purchase in open market, as was found most economical and advantageous to the Government. A few cords of fascines and poles used in the mattress work were purchased under public notice of ten days. The greater portion of this class of material, however, was obtained from the reservation by hired labor.

The plant has been increased by the addition of one light locomotive, suitable to the gauge of the road, which was purchased at a cost of $3,630, delivered at Astoria; three rock dump-cars and two 8-wheeled flat cars were made on the works; also by a pile-driver tender car which was designed and constructed at the works by hired labor. The pur-



U.S. Engr Office
Portland Oregon July 9. 1888
Chief of Engrs U.S. with the Annual Report
Thos H. Handyside
Lt Col Corps of Engrs U.S.A.

pose of this car is to carry one day's supply of piles, capping, stringers, and other material for the pile-driver, which is habitually at work at the extreme end of the jetty tramway. It extends over the two tracks and runs on six trucks. The iron-work for these cars was purchased in open market.

The facilities for receiving and handling material have been considerably increased, and some preparation has been made looking to increased appropriations, which will enable this work to be pushed forward vigorously.

The principal parts of the plant which have thus far been provided are two 13-ton locomotives, one specially designed pile-driver, with its tender-car, eighteen rock dump-cars, two flat cars, and four model barges capable of carrying about 280 tons of stone each.

The work is now in fair shape to be pushed forward rapidly as soon as funds in sufficiently large amounts are made available for the purpose. The stone which is now being used for the construction of the jetty is of good quality for the purpose, hard basaltic rock, and can be obtained in any desirable quantity on the Columbia River a few miles above the mouth of the Willamette. There is a reasonable prospect that a stone which will answer may be found nearer the works on the lower Columbia. The distance it is to be transported would be less than at present and, all other things being equal, it should be delivered at a less cost. The price now paid, 70 cents per short ton, on barges furnished by the Government at Fort Stevens, is considered reasonable, and it is doubtful whether as satisfactory stone can be furnished at less cost.

Investigations had been made, previous to my taking charge of this work, to ascertain the practicability of delivering stone on the work by rail. No suitable stone was found within a reasonable distance, over which it would be practicable to construct and operate a railroad, on which it could be delivered at a cost as low as the present water delivery from the middle Columbia.

With funds that may become available for operations during the present fiscal year, it is proposed to continue the construction of the jetty by means of the jetty tramway from which the rock is now dumped into place; and also by tugs and barges suitably constructed for the purpose, to deposit a large proportion of the rock from these barges directly in place along the line of the jetty.

An early completion of this work is exceedingly desirable; first, because of the necessity for giving relief to the commerce, which is large and important, that passes out and in over the bar; and second, to avoid the increased cost that must result from a deterioration and renewal of the plant, which is necessarily large and expensive. The jetty tramway from which the rock is delivered extends out on the proposed spit and is severely tried by every storm that visits this locality. It is very liable to be injured and parts of it washed away. To drive new piles into the sand through the rocks of the jetty and reconstruct it would be difficult and expensive.

Where so large an amount of money is invested as must eventually be in this project, and where so many interests are concerned, a sound business policy would dictate that the work should be pushed as rapidly as money could be profitably expended upon it.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

It is estimated that $1,000,000 could be profitably expended upon this work in the fiscal year ending June 30, 1890.

APPROPRIATIONS.

July 5, 1884, for commencing jetty on plan of majority of Board of Engineers of 1882	$100,000
August 5, 1886	187,500
Total	287,500

Money statement.

July 1, 1887, amount available		$153,959.31
From sale of powder to appropriation improving Chehalis River, Wash.		78.00
		154,037.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$102,791.06	
July 1, 1888, outstanding liabilities	11,000.00	
		113,791.06
July 1, 1888, balance available		40,246.25
Amount appropriated by act of August 11, 1888		500,000.00
Amount available for fiscal year ending June 30, 1889		540,246.25
Amount (estimated) required for completion of existing project		2,922,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics, bearing upon the improvement of the mouth of the Columbia River, were collected from the sources indicated, and are the most reliable that can be obtained:

FROM COLLECTOR OF CUSTOMS, PORTLAND, OREGON.

Arrivals and clearances of vessels and commerce at Portland, Oregon, during the year ending June 30, 1888.

	Coastwise.		Foreign ports.				Total.	
			American.		Foreign.			
	No. of vessels.	Tons.	No. of vessels.	Tons.	No. of vessels.	Tons.	No. of vessels.	Tons.
Arrived in 1887-'88	126	172,626	4	3,214	32	30,452	162	206,292
Cleared in 1887-'88	132	188,775	21	21,824	97	116,977	250	327,576
Arrived from foreign ports via domestic ports					73	98,826	73	98,826

COMMERCE.

July 1, 1887, to June 30, 1888:

Exports	$4,619,015.00
Imports	694,665.97
Duties collected	550,821.36

FROM COLLECTOR OF CUSTOMS, ASTORIA, OREGON.

Arrivals and clearances of vessels and commerce at Astoria, Oregon, during the year ending June 30, 1888.

	Coastwise.		Foreign ports.				Total.	
			American.		Foreign.			
	No. of vessels.	Tons.	No. of vessels.	Tons.	No. of vessels.	Tons.	No. of vessels.	Tons.
Arrived in 1887-'88	220	312, 444	5	4, 915	27	24, 117	32	29, 032
Cleared in 1887-'88	223	311, 424	9	8, 898	56	53, 545	65	62, 543
Cleared via Astoria from Portland			1	1, 080	54	75, 057	55	76, 147
Arrived from foreign ports via domestic ports			3	2, 853	60	80, 155	63	83, 008

COMMERCE,

July 1, 1887, to June 30, 1888:

Exports	$1, 182, 231. 00
Imports	112, 445. 00
Duties collected	37, 773. 84

FROM REPORT OF PORTLAND BOARD OF TRADE, SEPTEMBER 12, 1887.

Summary of business of the year ending July 31, 1887.

Registered tonnage, outward bound, tons		406, 918	Wheat exports ... centals	3, 754, 188
Registered tonnage, inward bound, tons		404, 629	Salmon exports ... cases	531, 819
Deep-sea tonnage, outward bound, tons		129, 847	Wool exports ... pounds	11, 569, 233
Deep-sea tonnage, inward bound, tons		127, 151	Domestic exports	$9, 507, 183
Flour exports ... barrels	521, 681		Foreign exports	6, 196, 722
			Total foreign and domestic exports	$15, 703, 905

Registered tonnage over Columbia River Bar from August 1, 1886, *to July* 31, 1887.

OUTWARD.

Month.	Sailing vessels.						Steam.				Coasters.		Total.	
	American.		British.		German.		American.		British.		American.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1886.														
August			6	5, 357			11	24, 251			9	2, 395	26	32, 003
September			9	8, 247			12	23, 963			3	1, 250	24	33, 460
October	1	1, 469	17	18, 944			7	15, 721			6	3, 801	31	39, 935
November	2	1, 947	19	20, 275	1	851	10	18, 233			6	2, 772	38	44, 078
December	2	2, 658	18	20, 625			10	22, 787			4	1, 328	34	47, 398
1887.														
January	2	3, 206	13	14, 313			8	18, 764			6	2, 038	29	38, 321
February			5	6, 509			8	16, 079			2	927	15	23, 515
March			6	8, 173			11	21, 293			9	2, 981	26	32, 447
April			9	8, 104			10	21, 771			3	1, 063	22	30, 938
May			4	8, 341			11	23, 651			7	2, 435	22	30, 427
June			2	2, 096			10	22, 114	1	203	5	1, 980	18	26, 393
July			3	2, 732			14	22, 841	1	203	3	2, 227	21	28, 003
Total	7	9, 280	111	119, 716	1	851	122	251, 468	2	406	63	25, 197	306	406, 918

Registered tonnage over Columbia River Bar from August 1, 1886, *etc.*—Continued.

INWARD.

Month.	Sailing vessels.						Steam.				Coasters.		Total.	
	American.		British.		German.		American.		British.		American.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1886.														
August	2	2,311	10	10,599	....	.....	13	27,580	....	.....	8	2,867	33	43,357
September	1	1,135	16	16,178	....	.....	11	21,137	....	.....	3	1,052	31	39,502
October	....	.....	15	16,446	1	851	11	20,065	....	.....	6	2,223	33	39,585
November	2	2,655	11	13,003	....	.....	11	20,582	....	.....	5	1,933	29	38,173
December	1	1,551	14	17,488	....	.....	9	18,889	....	.....	6	1,857	30	39,785
1887.														
January	1	1,655	6	6,406	....	.....	10	21,016	....	.....	3	1,519	20	30,596
February	....	.....	5	6,973	....	.....	9	15,726	....	.....	6	2,026	20	24,725
March	2	2,532	18	18,118	....	.....	10	20,727	....	.....	5	1,679	35	43,056
April	....	.....	5	5,049	....	.....	10	20,272	....	.....	4	1,610	19	26,931
May	....	.....	1	1,400	....	.....	11	24,106	....	.....	5	1,606	17	27,112
June	....	.....	....	.....	....	.....	11	21,694	1	203	5	2,598	17	24,495
July	....	.....	2	2,177	1	624	14	22,110	2	406	4	1,995	23	27,312
Total	9	11,839	103	113,837	2	1,475	130	253,904	3	609	60	22,965	307	404,629

Comparative statement of principal exports past six seasons.

WHEAT.

Seasons ending July 31—	Foreign.		Domestic.		Totals.	
	Centals.	Value.	Centals.	Value.	Centals.	Value.
1882	3,704,992	$3,965,518	437,899	$711,900	4,142,819	$6,667,418
1883	1,761,754	2,918,458	362,709	560,338	2,124,463	3,487,796
1884	2,276,809	3,[illegible]2,253	311,941	477,[illegible]25	2,588,750	4,189,978
1885	3,147,902	3,720,378	5[illegible]1,834	598,8[illegible]8	3,669,736	4,319,[illegible]03
1886	3,971,756	4,979,841	1,349,740	1,602,805	5,321,496	5,582,646
1887	3,042,316	3,889,499	711,872	988,936	3,754,188	4,878,435

FLOUR.

Seasons ending July 31—	Barrels.	Value.	Barrels.	Value.	Totals.	
					Barrels.	Value.
1882	526,003	$2,410,180	95,956	$443,612	629,991	$2,853,792
1883	353,829	1,684,919	139,471	708,854	493,300	2,393,773
1884	334,534	1,556,684	218,846	945,857	553,380	2,502,141
1885	198,208	796,839	182,316	656,485	380,523	1,453,324
1886	353,869	1,323,877	187,736	689,708	541,632	2,013,585
1887	383,773	1,412,208	137,908	548,447	521,681	1,960,655

SALMON.

Seasons ending July 31—	Cases.	Value.	Cases.	Value.	Totals.	
					Cases.	Value.
1882	308,824	$1,557,164	192,501	$981,767	501,325	$2,538,931
1883	367,388	1,940,991	280,944	1,460,181	648,332	3,401,172
1884	281,080	1,352,498	267,084	1,308,620	548,144	2,662,118
1885	296,285	1,228,441	363,583	1,494,315	660,138	2,757,756
1886	166,697	725,408	410,800	1,795,904	577,497	2,521,402
1887	159,707	816,707	372,112	1,925,590	531,819	2,742,297

Comparative statement of deep-sea tonnage past five seasons.

INWARD.

	1882-'83.		1883-'84.		1884-'85.		1885-'86.		1886-'87.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
American	30	37,219	17	21,064	17	22,044	14	19,169	9	11,839
British	59	57,066	72	71,121	97	91,737	132	137,138	103	113,837
Norwegian	1	1,145	2	1,386	.....	.....	1	901	.....	.....
German	5	4,817	1	417	4	3,618	3	2,622	2	1,475
Total	95	100,247	92	93,988	118	117,399	150	159,830	114	127,151

OUTWARD.

American	22	26,235	22	28,846	20	.....	14	19,323	7	9,280
British	60	57,845	73	71,051	97	.....	119	124,073	111	119,716
Norwegian	1	1,145	2	1,386	.....	.....	1	901	.....	.....
German	5	5,510	.....	.....	4	3,618	3	2,622	1	851
Total	88	90,735	97	101,283	121	3,618	137	146,919	119	129,847

S S 2.

CONSTRUCTION OF CANAL AT THE CASCADES, COLUMBIA RIVER OREGON.

The general scope of the improvement which it is desired to effect at the Cascades of the Columbia River includes a reach of about 4½ miles, where the river rushes through a narrow gorge in the Cascade Mountains. The fall in the distance is about 45 feet at high water and 36 feet at low water. The principal obstruction to navigation occurs at the upper end of the reach, known as Upper Cascades. The project for the improvement contemplates that the river should be improved below the Upper Cascades by removing bowlders and projecting points in the bed and banks, so as to give good navigable water from its lowest up to a 20-foot stage. The fall at the Upper Cascades is to be overcome by digging a canal about 3,000 feet in length across the neck of a low projecting spur around which the river is forced at the entrance to the gorge, and placing in this a lock and other suitable structures which would permit of the passage of boats up to a 20-foot stage of water in the river. This lock and canal to be so arranged that, should the future necessities of commerce so demand, additional structures may be added which will permit of navigation at much higher stages.

The first part of this project, that of improving the river below the foot of the Upper Cascades, is essentially finished. Besides accomplishing what was expected in aid to navigation, it has resulted in a material change in the regimen of the river at the two ends of the canal. The water-level, at what had previous to the improvement been considered low water, was found after it to be as much as 4 feet lower.

The difference of level between the head and foot of the canal, as now established, is 15 feet at high water and 24 feet at low water, and the difference in height between high and low water at the foot is 54 feet and at the head 45 feet.

Before the reference of the top of the lower miter-sill in the canal lock could be definitely established it was necessary to know the effect that the river improvement would have upon the low-water level at the

lower end of the canal. This being now determined the construction of the gate masonry and side walls of the locks can be proceeded with.

The plan on which the future work in the canal, with its lock and accessories, is to be prosecuted has for its object to make this portion of the river available for navigation to a stage up to 20 feet, at the earliest possible moment, with the funds that are from time to time appropriated for the purpose, and may be briefly outlined as follows:

A lock is to be constructed in the lower half of the canal having an available length for boats of 462 feet and a width of 90 feet. There will be 8 feet of water over the miter-sills at low water, which corresponds to a reading of 72 feet on the gauge established at the lower end of the canal. The corresponding reading on the gauge at the upper end will be 96 feet. The lift of the lock at this stage will be 24 feet.

At the lower end of the lock there will be provided a lower guard-gate, and at a lock's length above the upper lock-gate, an upper guard-gate to exclude high water. Immediately above this there will be a caisson gate to be used in case of needed repairs to this gate.

The top of the gates and the walls of the lock will be placed at reference 110, the height necessary for lockage to a level of 20 feet above low water. The lower guard-gate will be carried up to reference 100 and the upper guard-gate to reference 141.5. This last reference is 1.5 feet above the highest water at the head of the canal. The embankment on the river side of the canal will be carried up to a reference at least 2 feet above the highest water in the contiguous portions of the river. This will bring it up to 142, about the head of the canal. The top of the caisson will be at reference 110.

Above and below the guard-gates the canal will be made wider in order to facilitate entrance to the lock and to provide a limited harborage for boats awaiting their turn to go through.

This work is all designed with the idea of ultimately providing for the passage of boats at stages of water higher than 20 feet, should it be found that the exigencies of the commerce of the river require it.

To the present time there has been excavated from the line of the canal in the neighborhood of 250,000 cubic yards of material of various kinds, such as bowlders, gravel, sand, and bed-rock conglomerate. To complete the canal with its lock structures and guard-gates, it is estimated that about 400,000 cubic yards of material, of the same general character, are yet to be excavated.

About 40,000 cubic yards of dry stone-wall and slope paving have been laid on the sides of the upper and lower entrances to the lock; considerable concrete and rubble work have been done which was necessary to keep out water during process of construction; the concrete foundation for the caisson recess is partially finished. About 2,600 cubic yards of stone have been cut and prepared for use in the further construction of the entrance walls.

At the commencement of the fiscal year active operations were in progress on the river, with Capt. Willard Young, Corps of Engineers, in local charge as assistant to Capt. Charles F. Powell, Corps of Engineers. On the 7th of July, 1887, Captain Young was relieved by Lieut. Edward Burr, Corps of Engineers, who has been in local charge since that date. His detailed report of operations for the year is herewith submitted.

By virtue of paragraph 1, Special Orders, No. 60, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., March 14, 1888, I relieved Captain Powell of the charge of this work April 20. At that time active operations on the work had been practically suspended for

about two months, on account of a want of funds. They can not be resumed until further appropriations are made by Congress.

During the fiscal year 22,645 cubic yards of material was excavated from the canal and the sites of the upper and lower guard gates; 1,768 cubic yards of concrete and 597 cubic yards of rubble masonry were made in foundation for caisson recess and wing-wall; 232 cubic yards caisson masonry and 507 cubic yards wall masonry were cut. The slopes on the upper entrance to the canal were paved with 1,321 cubic yards of stone. A small quantity of dimension stone was quarried from bowlders found during excavation. Some repairs and additions were made to the buildings with the view to better accommodation of a large force of men and other miscellaneous work, as described in Lieutenant Burr's detailed report.

The canal is at present closed at the upper end by an embankment of earth, which keeps out the water to its highest known stages. The lower end is closed by a temporary coffer-dam, which excludes the water only to a height of 22 feet above the low-water stage of the river, or to reference 94 on the lower gauge. It will be impracticable to build this dam higher because of the difficulty that will be experienced in preventing the water from forcing its way around its southern end, through the gravel and sand in which this end terminates. The bed-rock, or a stratum impervious to water, can not be reached in this locality within any reasonable limit. Work in the canal and lock-pit must therefore be confined to such times as the river is at a lower stage than the top of this coffer-dam.

With the funds that may be next appropriated it is proposed to prosecute the work in such a manner that the lower guard-gate, with its necessary masonry, may be placed in position as early as possible. This will give command of the lock-pit up to a 28-foot stage of the river, at least. Temporary arrangements can be made here which will exclude the water to a higher stage, thus giving us a much longer season in which to carry on work in the pit, should it be found necessary in order to judiciously expend the money which it is hoped that Congress will appropriate for this purpose.

From the general outline given of the condition of the work, it will be seen that a little more than one-third of the excavation required to complete the canal has been accomplished. It is doubtful if so large a proportion of the other necessary work is finished.

To bring the canal to its present state with the small appropriations that have from time to time fallen to its lot, it has taken a period of twelve years. At this rate it will require perhaps twenty-four years more before any benefit to commerce will result from this work, or the country receive the least remuneration for the money expended. A generation will have been born and gone to its grave between the beginning and the ending of an enterprise which a healthy syndicate would have prosecuted to completion within six years at farthest after commencement, and been in the enjoyment the balance of the time of a liberal income from the money invested.

From 1876, the date of the first appropriation for this work, up to the present time, but $1,142,500 have been made available for its prosecution. This is an average of about $95,000 per year. The various appropriations that have been made during this time, the total of which is given above, if invested in an enterprise paying 4 per cent., with their yearly interest re-invested at the same rate, would amount to $1,490,490, an excess over the amount appropriated of nearly $348,000, for which there is nothing to show. The next yearly interest would amount to $79,600, almost as much as the average yearly appropriation.

as could be "profitably expended," say $500,000 each year, this amou will be $3,449,000, a saving of $2,383,800. The work will be complet in six years, and the people at once begin to reap the benefit of t money invested. This exhibit of the case is purely from the mone dealer point of view. It takes no note of the large increase in the co of the work resulting from deterioration and renewal in plant and a pliances, and other causes that must necessarily pertain to a long ter of years and small appropriations; nor does it include the large amou that results from the difference in freight rates on the commerce th would take this new route, were the improvement finished, but whi now goes by some other to market.

For all works of this character, where the improvement to be effect must be completed before any advantage can accrue to commerce, does seem that the policy of small appropriations running through long term of years enhances enormously their ultimate cost.

The upper Cascades of the Columbia River is an absolute barrier navigation. It must be flanked by a canal and lock in order that t commerce of the river may pass by it. These must be finished, the la bowlder removed from the canal, and the last rivet driven in the loc gate before one penny's return can be had for any outlay that may ha been made to effect the improvement. On sound business principles would therefore seem that this work should be liberally appropriated f and pushed forward to completion as rapidly as possible, in order th some return may be had within a reasonable period of time for t large amount of money already expended.

APPROPRIATIONS.

June 14, 1876, canal around Cascades of Columbia River, Oregon	$90,0
June 18, 1878	150,0
March 3, 1879	100,0
June 14, 1880	100,0
March 3, 1881	100,0
August 2, 1882	265,0
July 5, 1884, improving Columbia River at Cascades, Oregon	150,0
August 5, 1886	187,5
Total	[illegible]

Amount (estimated) required for completion of existing project	$1,550,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The Cascades of the Columbia River are in the collection district of Willamette. The nearest port of entry is Portland, Oregon, 63 miles distant by river. The nearest light-house and works of defense are at the mouth of the Columbia River, 150 miles distant. The amount of revenue collected at Portland for the year ending June 30, 1888, is $550,821.35.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cascades Locks, Oregon, June 30, 1888.

SIR: I have the honor to submit the following report of operations for the improving of the Columbia River at the Cascades, Oregon, for the year ending June 30, 1888. I assumed local charge of the work on July 9, 1887, relieving Capt. W. Young, Corps of Engineers, of that duty. The principal items of work for the year were as follows:

Excavation:
- For caisson chamber and high wing-wall on left.
- For low wing-wall on left.
- Of canal prism near site of high guard-gate.
- Of canal prism at lower entrance.

Masonry:
- Of low wing-wall on left.
- Of caisson chamber and high wing-wall on left.

Cutting stone for caisson masonry and for canal side-walls.
Paving of both banks of upper entrance.
Quarrying of bowlders for dimension and paving stone.
Grading of canal grounds with spoils of excavation.

EXCAVATION.

The materials excavated were conglomerate, gravel, and silt. The following table gives the quantity of each excavated, the locality from which taken, the total cost, and the estimated cost per cubic yard:

Material and locality.	Quantity, cubic yards.	Total cost.	Cost per cubic yard.
Gravel:			
Caisson chamber and high wing-wall	4,168	$3,428.73	$0.822
Conglomerate:			
Caisson chamber and high wing-wall	2,512	2,442.21	.976
Canal prism, site of high guard-gate	2,152	2,099.71	.976
Canal prism, lower entrance	754	735.90	.976
Low wing-wall	184	354.57	1.927
Silt: Canal prism, lower entrance	12,875	5,613.87	.436
Total	22,645	14,674.99	.....

The conglomerate is composed of basaltic cobbles and bowlders of considerable hardness, embedded in a matrix of volcanic materials. This matrix is of varying hardness and is sometimes of only the consistency of stiff clay. The conglomerate resulting from these materials is very ununiform, requires drilling and blasting to remove it, and rapidly disintegrates upon exposure to the atmosphere.

The drilling was done with steam-drills, using 1¼-inch cross-shaped bit. The average depth drilled per hour was 4.7 feet. The drilling was more or less spasmodic,

depending on other work, and no fair estimate could be made of the cost per foot of hole drilled. A few holes were hand-drilled in cleaning up excavations.

The blasting was done mainly with No. 2 dynamite powder (40 per cent. nitro-glycerine). A small quantity of low grade dynamite powder and black powder was also used. The quantity of conglomerate removed by the use of powder was 5,418 cubic yards, requiring the use of 2,514 pounds of No. 2 powder, 125 pounds of low grade powder, and 150 pounds of black powder. The total amount of powder used amounted to 2,789 pounds, or 0.51 pounds per cubic yard blasted. The cost of blasting was $615.04 for powder; $69.86 for caps, fuzes, etc., and $277.50 for labor; a total of $1,062.40, or $0.196 per cubic yard blasted. The conglomerate from the site of the low wing-wall was excavated in leveling up the surface for the masonry, and was removed by picks and gads.

The gravel is well compacted and contains many large bowlders. When undisturbed it stands temporarily at a very steep slope, but when softened by the continued winter rains it is easily brought down from such slopes by any blasting in its vicinity. Much trouble, delay, and expense was experienced from this cause in the cut for the caisson chamber. This cut had a depth of 43 feet in gravel, and 13 feet in conglomerate, and the blasting of the latter was continually bringing down the gravel slopes which had been left too steep.

The silt removed from the canal prism at the lower entrance was mainly a deposit inside the lower bulkhead by the river during the extreme stages of high water. It was principally of fine sand. Some gravel was intermingled with it. In removing the deposit, sluicing was resorted to as being cheaper than the usual method of dumping outside the embankment, and as placing the material where it was less likely to be returned by high water into the canal.

A dump-box was placed in a convenient position and a 24-inch flume was led from it about 250 feet into the river below the bulkhead. The water was furnished by a 5-inch centrifugal pump from drainage pits in the canal, and at the rate of about 1,000 gallons per minute on an 18-foot average lift. It was led into the dump-box by a 12-inch flume. To pass the flume over the bulkhead and give the necessary grades the dump-box had to be placed about 12 feet above the material to be removed, and the latter, after being loaded into boxes, was hoisted into it by a derrick, and started into the stream by several men with shovels. A stream of water from a hose was tried for this last purpose, but its action was not rapid enough. This arrangement worked very satisfactorily with sand, and with use of one derrick the maximum reached in ten hours was 360 boxes containing nearly 350 cubic yards. But owing to breakages and shortage of water the average was not more than 175 boxes.

The total material excavated during the year amounted to 22,645 cubic yards, raised in 24,740 boxes, and costing $14,674.99.

GRADING.

Part of the material excavated for the caisson chamber was used in bringing the grade on the left of the canal to its finished level. The remainder and the spoils from the excavation near the high guard-gate were used in strengthening the dam from the canal embankment to Powder House Point. One thousand two hundred and fifty-four cubic yards of gravel and conglomerate excavated from the lower entrance to the canal were dumped outside of the protective wall in grading on that side of the canal.

The total material used for grading amounted to 12,365 cubic yards, costing $3,312.27 to grade, or $0.268 cents per cubic yard.

This includes the cost of raising and repairing the stable in grading under it.

MASONRY.

Low wing-wall on left.—This wall is located at the head of the low-water lock and is of the same height as the lock-walls. The conglomerate at that point has an average surface level of about reference 92 and was leveled up to about reference 95 with concrete as a foundation, upon which a wall of large rubble was built. To prevent the water from working around the wall it was extended 175 feet back from the lock-walls, compact gravel being found at that distance, and a joint was made between the end of the wall and the gravel by a fan-shaped mass of concrete. The wall was completed for a length of 130 feet and the excavation filled with clay and selected gravel well rammed.

Including 297.15 cubic yards of concrete at $9.808, 579.51 cubic yards of rubble at $9.890, and 412 cubic yards of filling at 90 cents, the total cost was $9,016.72. The concrete and masonry were laid with Portland cement, and the prices per cubic yard are estimated.

Caisson chamber and high wing-wall.—The caisson gate is located immediately in front of the high guard-gate, and is designed for use as a dam that can be rapidly put

ıto position for repairs. As designed, it is a rectangular box 94 feet long, 11 feet ·ide, and 25 feet high, to be built of steel. When in use it is to rest against a ıraight sill, and when out of use it is to be floated back into an arched chamber proided for it under the left slope. This chamber, just above the masonry of the high uard-gate, has incorporated with its down-stream wall the left high wing-wall.

The excavation for this work, commenced in the previous year, was completed in ·ovember last, and the laying of masonry begun and continued until frosty weather nd the exhaustion of funds caused its suspension in January.

All loose and soft pieces of rock were removed from the foundation, and the surface ırefully cleaned with brooms and a stream of water. This cleaning could only be one immediately ahead of the concreting, on account of the rapid disintegration of he conglomerate. A pocket of clay was found at the foundation level, though 15 feet elow the surface of the conglomerate. A stream of water flowing through crevices aused some trouble with the slow-setting cement in use.

In placing the concrete the bottom and sides of the cut were first plastered with ement mortar to close all crevices and make a water-tight joint. The concrete was eposited in thin layers, each being well rammed, and large rubble was imbedded in t, care being taken to keep the pieces well separated and away from the faces of the ·alls. The chamber walls are concrete faced. Cut stone is used only for the outside orners of the chamber, and for meeting and rubbing faces for the caisson. The conrete was hand-made in the usual manner, by mixing the cement and sand dry, adding he stone, and then the water as the material is turned to a thorough mixture. The roportions were, by volume, 1 of cement, 2 of sand, and 7 of broken stone.

Other proportions were tried, using larger proportions of sand and stone than in the bove, but these proportions were the highest that gave acceptable results. The maerials were not all the best of their kinds. The cement was English Portland, prinipally of Knight, Bevan & Sturges's make. It could not be bought subject to test, nd such cement as the limited Portland market supplied had to be accepted.

The sand was from the river bars and, though clean, was of poor quality, being fine nd containing considerable mica.

The stone was broken by a small crusher and the finer parts screened out. Besides eing expensive, it was not altogether acceptable on account of the flat shape of the ieces. Some gravel was used in the concrete for the low wing-wall, but the supply o be had was very limited.

Kind of masonry.	Quantity, cubic yards.	Total cost.	Cost per cubic yard.
ine axed stone in sill and meeting faces	34.44	$1,196.34	$33.256
ortland cement concrete	1,470.67	14,425.18	9.508
Total	1,505.11	15,621.52	.....

The cost of the concrete was divided up as follows:

Items.	Total cost.	Cost per cubic yard.
ıll labor, including mixing, laying, timbering, etc	$4,147.93	$2.820
ement	5,236.50	3.560
tone	3,525.78	2.389
and	943.93	.640
ıll other materials	574.04	.390
Total	14,425.18	9.808

One thousand four hundred and thirty-one barrels of cement were used, producing ,470.67 cubic yards of concrete, in which was embedded rubble measuring 15,525 ubic yards. On account of the extent of the surface exposed on the foundation and ides, the proportion of cement used for mortar was unusually large.

CUTTING STONE.

The stone cut for the side walls of the canal is quarry-faced ashlar with a batter of 2 on 1 and rises of 2 feet, 1 foot 10 inches, and 1 foot 8 inches. The beds and oints are dressed for laying dry.

The stone cut for the caisson masonry was nearly all finely dressed with patent xes for the sill and meeting faces.

The following table gives the details of the work for the year:

Stone for—	Caisson masonry.	Side walls.	Totals.
Days' labor of stone-cutters	1,132.35	727.0	1,859.35
Cubic yards of stone cut	232.0	507.1	739.1
Square feet of fine cutting	3,195.4		3,195.4
Square feet of rough cutting	10,783.2	23,255.3	34,038.5
Ashlar with rise of 2 feet ... lineal feet		1,256.1	2,803.8
Ashlar with rise of 1 foot 10 inches ... do		897.3	
Ashlar with rise of 1 foot 8 inches ... do		750.4	
Lineal feet of base course cut 2 feet rise		55.2	55.2
Cubic yards cut per day per man	0.205	0.697	
Square feet of fine cutting per day per man	4.30		
Square feet of rough cutting per day per man	27.50	32.0	
Square feet of total cutting per day per man	12.30	32.0	
Cost per cubic yard for stone cutters' labor	$19.512	$5.725	
Cost per cubic yard for handling material, etc	13.743	5.428	
Total cost per cubic yard	33.256	11.153	
Total cost per square foot of cutting	0.514	0.243	
Total cost for the year	7,715.59	5,655.72	

PAVING.

The following paving of slopes of the upper entrance to the canal with large rubble was done during the year.

Cubic yards of paving laid on slopes, ramps, and berms	1,321.57
Square yards of paving on:	
Slopes 3 feet thick	332.99
Ramps 1.5 feet thick	188.6
Berms .75 foot thick	33.8
Cost per cubic yard	$4.50
Cost per cubic yard exclusive of value of stone	[illegible]
Total cost for year	[illegible]

QUARRYING.

No quarrying was done during the year except to obtain a few special pieces of dimension stone and to remove bowlders met with in the course of excavations.

Dimension stone quarried	cubic yards	[illegible]
Paving stone quarried	do	[illegible]
Total stone quarried	do	[illegible]
Total cost of stone quarried		[illegible]
Cost per cubic yard		[illegible]

BUILDINGS.

Besides the usual maintenance and repair of buildings, the following special work was done:

A lodging house with sleeping, washing, drying, and store-rooms for 215 men was built during the year and two old buildings torn down. The new building is 175 by 36 feet and has two stories. Total cost $3,991.85.

A latrine was built in connection with the new lodging house with 1,310 feet of 6-inch main sewer and 75 feet of branches to other buildings. Total cost $913.09

New sheds for stone-cutters were completed, except the placing of the overhead traveler on the gantries. The gantries are 260 feet long and the traveler has a span of 34 feet, covering two rows of stone-cutters' sheds, each 132 feet long and 12 feet wide, with a 9-foot tramway passage between them.

Provision is thus made for sheltering twenty-two stone-cutters, and for a length of 128 feet for piling rough and cut stone. The traveler is maneuvered entirely by steam-power, furnished by an old hoisting engine geared for the purpose. Total cost, including the rebuilding of the engine, $2,740.98.

SAND.

Difficulty is experienced in obtaining good sand for concrete.

Search has been made, but no good sand found on the navigable reach of the river between here and the Dalles. The sand used during the last season, as previously described, is of poor quality and does not give satisfactory results, but no better quality appears to be had at a reasonable cost. By prospecting on the premises of the Oregon Railway and Navigation Company, just across their line from the canal grounds, a bed of coarse sand has been uncovered which, it is thought, will do fairly

well for concrete. It is not as clean as is desirable, but it is easily accessible and, being of probably large extent, it is thought to be the best opening known at present.

The question of manufacturing sand by crushing and grinding stone has been under consideration. Tests made with the fine refuse from the stone-crusher showed that screenings through a one-quarter inch mesh-screen, when mixed in cement in the proportion of 6 to 1 by weight, would produce a stronger mortar than could be obtained in the proportion of three to one with any natural sand available. Mixed in the same proportion the crusher refuse gave results about double those of any natural sand. However, on account of the difficulty of obtaining suitable stone and of the unknown cost of obtaining and pulverizing it, this method of obtaining sand is not recommended until all sources of fair natural sand are exhausted.

A suitable quarry for stone for concrete is a pressing necessity for future economical construction of lock masonry.

The bowlders heretofore quarried give fairly economical results in dimension and rubble-stone, but when this stone is used for crushing the cost of the crushed stone becomes unreasonably great, raising the cost of concrete to that of good rubble masonry. Search has been made for a quarry as a source of a more economical supply, and while the stone found has not been considered suitable for dimension stone, it would no doubt be amply good for concrete.

MISCELLANEOUS.

The protective wall was repaired by pointing the joints with cement mortar, as it was found that the swell in the river, which is considerable at the foot of the rapids, was drawing out the gravel backing through the open joints of this dry rubble-wall. The lower bulkhead was overhauled and made water-tight as far as possible by excavating its lower face and recalking and repitching the seams. It can not therefore be made serviceable until connected with a longitudinal bulkhead at its south end.

The reef of conglomerate outside of the protective wall near its lower end was partly broken up by blasting, with the expectation that higher water would carry away the fragments. Five hundred and thirty-three feet of holes were steam-drilled and blasted, breaking up an estimated quantity of 310 cubic yards of conglomerate at a cost of $244.

Table giving the meteorological and gauge summaries for the year.

Date.	Rain-fall.	Days on which rain or snow fell.	Average temperature 12 m.	Highest reading of gauges.		Lowest reading of gauges.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1887.							
July	.....	.....	75.6	129.9	115.9	115.2	100.0
August	0.40	2	76.3	114.8	99.4	106.9	88.0
September	4.02	7	67.9	106.5	87.4	101.1	79.1
October	3.98	8	60.9	101.0	79.0	99.1	76.0
November	7.65	13	48.3	100.4	77.9	98.4	75.1
December	20.60	25	44.3	100.2	77.8	98.2	74.9
1888.							
January	10.90	18	27.7	106.2	87.1	93.7	70.2
February	3.59	13	50.4	104.8	85.3	100.8	78.8
March	5.74	15	53.6	101.7	79.9	99.3	76.6
April	2.23	13	64.6	110.9	93.8	101.1	79.2
May	0.36	6	70.5	115.6	100.5	109.7	92.5
June	6.43	19	67.3	121.9	107.9	115.9	100.7
Total	65.90	139	59.0	129.9	115.9	93.7	70.2

NOTE.—Reading of adopted low water at head of canal is 96; at foot of canal is 72.

The statement forwarded herewith gives in detail the expenditures for the year on the different items of the work.

Very respectfully, your obedient servant,

EDW. BURR,
First Lieut. of Engineers.

Maj. THOMAS H. HANDBURY,
Corps of Engineers, U. S. A.

REPORT OF BOARD OF ENGINEERS.

WASHINGTON, D. C., *April* 12, 1888.

SIR: The Board of Officers of the Corps of Engineers, convened by Special Orders No. 5, headquarters Corps of Engineers, United States Army, Washington, D. C., February 4, 1888, to consider and report upon plan submitted by Capt. Charles F. Powell, Corps of Engineers, for the construction of the locks at the Cascades, Columbia River, Oregon, respectfully submits the following report:

The Board assembled at Washington, D. C., February 6, as directed, and carefully considered the report and drawings before it. These had been submitted by Captain Powell, in compliance with instructions of the Chief of Engineers, which required them to be according to the project for the work as it was understood to be approved. This project was based upon a report dated November 13, 1880, which was submitted by a Board of Engineer Officers who had the subject under consideration. In order to clearly understand the plan proposed the Board deemed it necessary that Captain Powell should appear before it in person to more fully explain his views. It was therefore decided to adjourn to await his arrival, the Chief of Engineers having consented to order him to be present at its next meeting.

By Special Orders No. 7, headquarters Corps of Engineers, U. S. Army, Washington, D. C., February 7, 1888, the Board reconvened on February 24, and after hearing Captain Powell's explanations adjourned to meet in New York, to consult Lieut. Col. D. C. Houston, Corps of Engineers, a member of the Board of 1880, as to the meaning of the project submitted by that Board. This project is stated in the following extract taken from the report:

* * * * * * *

That there should be but a single lock at the foot of the Cascades Canal to accommodate the low-water system of improvement. Its capacity should be 462 feet by 90 feet to accommodate one tow-boat and three barges. It should have a lift of about 24 feet. The clear gate-openings should be reduced to 70 feet so as to diminish the weight of the gates. It should be provided with a guard-gate at its head and foot, so that it may readily be pumped out in case of needed repairs or vessels being wrecked in it. There should be a guard-gate at the head of the canal, the top of which should be at least 2 feet higher than the highest water. In case the high-water system is hereafter introduced this guard-gate will form the upper gates of a lift and guard-lock which must then be constructed at the head of the canal. The prism of the canal should be 90 feet wide at the bottom. The sides should be carried up vertically to within 1 foot of low water by strong timber cribs filled with stone, and then to a height of 11 feet by a dry stone wall. Here there should be a berm at least 15 feet wide, and then there should be a paved slope of 1 upon 1, leading up to the top of the canal embankment, which should be on a level with the top of the guard-gate at the head of the canal.

The following is a summary of the recommendations of the Board:

(1) Improvement of the river with a single lock near the foot of the main rapids, for navigation up to 20 feet above low-water-gauge No. 2, and a guard-gate at the head of the canal to exclude high water.

(2) Should it be found that this method of improvement will not give the desired navigation up to a stage of 20 feet, gauge No. 2, at an admissible cost, the next step would be the construction of a lock behind Bradford's Island and a dam across the river from the island to the right bank.

The Board remark, in conclusion, that the construction of these works will admit of their easy adaptation to an all-the-year-round navigation, should it be required in future. It would necessitate the construction of a guard-lock at the upper end of the canal, involving but an additional set of gates.

From the foregoing it will be seen that the former Board only provided for navigation up to a stage of 20 feet above low water by a canal around the Cascades, and that no mention was made of navigation at

higher stages, except the suggestion that the guard-gate of the canal, with the addition of a pair of gates, might be made to form a guard-lock for an adaptation of the recommended project to one providing for an all-the-year-round navigation. The route to be taken by boats below this lock at such times was left indefinite. The objection to using the entire low-water canal recommended by the Board, during the higher stages, seemed to be the difficulty that it was expected boats would experience in passing Big Eddy Rapids and into the lower end of the canal when the water had risen higher than 20 feet above low water. All the gates of the lock and canal were to be of wood. Following the report of the Board, which received the approval of the Chief of Engineers and Secretary of War, Captain Powell, the officer in charge of the work, submitted in 1883 a proposition to change the gate span of the canal from 70 feet to 90 feet and make the gates of steel. These proposed changes were referred to the members of the Board for their opinion. and after discussion it was decided that the plan submitted by the Board should be adhered to.

In 1885 Major W. A. Jones, the officer then in charge, proposed in a letter to the Chief of Engineers to reduce the width of the lock to 80 feet and make the gates the full width of the lock in order to omit the shoulders at the gates provided for in the original project, which seemed to him to be objectionable. This communication was referred to the surviving members of the former Board and also to Lieutenant-Colonel Poe, the officer then in charge of the St. Mary's Falls Canal, and after due consideration it was decided, with the approval of the Secretary of War, that the gates should be extended to the full width of the lock, but that the latter should retain its original width of 90 feet.

In the drawings before the Board submitted by Captain Powell, the location of the canal, the size of the lock (the height of its walls and lower gates being sufficient for the passage of boats to a stage of 20 feet above low water) and the lower guard-gate are in accordance with the project of the former Board, and the width of the gate-span has been changed, as subsequently approved, to the full width of the lock. The lock has been moved up-stream and the guard-gate for the head of the canal in the Board's project has been moved down-stream and with the upper gates of the lock forms a second lock of the same dimensions as the one approved. Captain Powell proposed to excavate the bottom of this second lock to a depth of 4 feet below the level of the bottom of the canal above the upper gates, in order to provide for the passage of boats with a draught of 8 feet by a single lockage at higher stages than 20 feet above low water on gauge No. 2. The upper gates of the first lock are increased in height accordingly, and its upper guard-gate is retained and placed so as to leave an available length of 300 feet for lockage between it and the upper gate of the second lock. By using the last two gates mentioned the passage of boats is permitted to a height of 40.7 feet above low water on the lower gauge. The average duration of the water above this level, according to the observations of the last nine years, is twelve days per year. The modifications proposed by him, therefore, practically provide for an all-the-year-round navigation through the canal.

It is also proposed by Captain Powell to place a caisson gate in front of the upper lock-gates and gradually increase the width of the portion of the canal above this gate from 90 feet near it to 250 feet at its head or junction with the river, in order to allow boats to enter it with greater ease, supply a harbor for them out of the river-currents while waiting to pass through the locks, and also to enable them to pass each other

in the canal. For the same reason the width of the canal below the locks is increased to 140 feet. The canal embankment is continued at a height of 2 feet above the highest water from its upper end to below the upper-lock-gates, after which it gradually diminishes in height 6 feet and then remains level on top to nearly its lower end. The upper lock-gates are carried to a height of 6 inches below the highest portion of the embankment to serve as guard-gates for the canal.

In the report accompanying the drawings, a copy of which is herewith, Captain Powell fully explains the proposed modifications and gives the reasons therefor. He also recommends that reference 96 on gauge No. 1 be taken as the low-water level at the head of the canal, and reference 64 on gauge 2, or the lower gauge of the canal, be taken as the level of the lower miter-sill of the lower lock. For a navigation of 8 feet draught this would place the level of low water at the foot of the canal at reference 72 on the same gauge. The Board of 1880 in their report remark as follows:

After careful examination this Board agrees with the opinion expressed by the Board of Engineers for the Pacific coast in the report referred to (dated August 19, 1879), "that actual construction ought to await the improvement of the river from the foot of the main rapids to the lower steam-boat landing" and for the reasons stated.

The effect of removing the rocks and reefs in the bed of the river will be to lower the water-surface at a low stage, and the removal of the projecting points above low water will increase the cross-section of discharge and reduce the velocities at higher stages.

The amount of this lowering of the water-surface can only be determined practically, as it is absolutely impossible to calculate it with any degree of accuracy. The date of final completion of the work for navigation at a low and medium stage need not be deferred by the improvement of the river or lower approach to the canal. The excavation of the canal prism may be continued. The stone for the locks can be prepared, the timber for the gates purchased and seasoned, and other materials accumulated, so that when construction is actually begun it may go forward with the greatest practicable rapidity.

From the foregoing quotation it is apparent that the projects submitted by both of the preceding boards which have discussed this subject contemplated an advanced state of river improvement below the canal before the level of low water for navigation was established, and the reference of the lower miter-sill of the lock determined.

Captain Powell, in his report before referred to, states that—

It should be explained that 96 on gauge 1 is ordinary extreme low water of navigation. A still lower stage on an open river, and lower by about .5 of a foot gauge 1, or about .7 of a foot gauge 2, has occurred, it is believed, at intervals of ten to twenty years, but only once in the last nine years, and when an open river dropped to a lowest reading of 95.6 gauge 1 and remained below 96 for eight days.

In regard to the effect of the river improvement lowering the low-water level below the canal and the probable result of its continuance, Captain Powell states:

That the river work, as far as affecting this lowering, is accepted as completed. That was the decision of my predecessor, with the concurrence of the supervising engineer, I believe.

Should this work continue, he adds:

The resulting low-water surface might be 70 or even less. If it were made as low as 69.2, a sill at 64 would fail to pass an 8-foot draught on the average, according to records for the last nine years—twenty-seven days annually—when the river was open. If the low-water surface were lowered to 70.6, the average duration of less than 8 feet depth on a sill at 64 would be eight days.

The Board, after a careful study of the subject and fully discussing with Captain Powell the plan submitted by him, as well as consulting with Lieut. Col. Houston, is of the opinion that the project for the exca-

struction of the Cascades Canal should at this time be limited to providing for navigation up to a stage of 20 feet above low water, which conforms to the extent of the project submitted in the report of the Board of 1880. As to the details of the project, it is deemed advisable to depart from those heretofore approved. It is accordingly recommended that the location of the lock and the position of the guard-gates of the canal a lock's length above the upper gates of the lock, as proposed by Captain Powell, be approved; the size of the lock to remain the same as that included in the project of the Board of 1880.

The upper guard-gate of the lock should be omitted, as it is rendered unnecessary by the changed position of the guard-gate of the canal, and further work upon the caisson gate should be suspended as soon as the recess for it now under construction is completed, as the Board regards this gate of doubtful utility. All the work proposed by Captain Powell to provide for navigation for stages higher than 20 feet above low water should also be omitted, including the excavation of the bottom of the canal between the guard-gate in its new position and the upper gates of the lock. The proposed excavation is advocated by him as necessary to permit boats with a draught of 8 feet to pass through the canal at a single lockage during stages from 20 feet to 24 feet above low water; the only other method of accomplishing the same object being to increase the height of the walls and lower gates of the lock. The Board does not regard the prospective advantage to be gained to navigation by the increase in depth of what can eventually be used as a second lock at high stages and the consequent lowering of the upper miter-sill of the lock sufficient to warrant the expenditure at this time. It will be observed that the omission of this work, even if the project be extended at some future day for navigation at higher stages, will only affect and slightly delay the passage of boats by the use of two locks instead of one during a range of 4 feet in the height of the water.

With the present advanced state of the river improvement, which permits boats to pass without difficulty up to the foot of the canal, the Board considers it inadvisable to further delay the actual construction of the lock. It therefore recommends that the level of low water be assumed from the data that has been obtained during the last nine years, as proposed by Captain Powell. This will make low water above the lock 96 on the upper gauge, and below the lock 72 on the lower gauge; and for an 8-foot draught the upper and lower miter-sills of the lock 88 and 64 prespectively. Should the continuance of the river improvement result in a further lowering of the low-water level that is injurious to navigation, the proper remedy for the difficulty can only be ascertained by a study of the conditions existing at the time.

The Board further recommends that the top of the gates and of the walls of the lock be placed at reference 110, the height necessary for lockages, to a level of 20 feet above low water; that the upper and lower guard-gates of the canal be carried to the heights given on the drawings, or references 141.5 and 100 respectfully; that the sides of the canal be built of dry stone-masonry to a height which will correspond to a rise of the river of 20 feet at gauge No. 2, *i. e.*, to reference 92 below the lock, and to reference 110 above the lock, with the exception of those portions of the walls that support the upper guard-gate, which should be of masonry laid in cement mortar; that the berme be given a width of at least 15 feet, as recommended by the Board of 1880, and that the top of the canal embankment above the upper guard-gate and the masonry supporting it be carried up to reference 142, about 2 feet above the highest water at the head of the canal. Below the guard-gate, for

economic reasons, the top of the embankment should be reduced to an elevation about 2 feet above the highest water in the contiguous sections of the river, unless there is an excess of material to be excavated from the canal prism.

The increase of width in the canal above and below the lock and guard-gates, as shown on the drawings, is regarded as advantageous to navigation, and is therefore recommended for approval. It may be necessary to supplement the work at the head of the canal by fender-piling or a series of detached cribs filled with stone, in order to facilitate access to it and to prevent boats from being carried over the rapids while endeavoring to enter it. The Board favors the latter method, as it affords all the protection necessary and allows the escape of drift that may accumulate at the head of the canal through the openings between the cribs.

Captain Powell proposes to fill and empty the locks by culverts under the miter-sills and in the floor of the chamber. The experience of the members of the Board is against this method, as it places the valves in the deepest water, renders them most difficult of access in case of necessity, more liable to damage and obstruction from silt and débris, and the aparatus for opening and closing them more complicated. With culverts in the side-walls these objections are removed. It is therefore suggested that additional study be given to the location of the culverts before their position is finally determined.

When the work proposed herein is completed and its effect upon navigation, together with that of other improvements upon the river in progress, and for which plans have been approved, is known, it is possible that some extension of the project now presented for the canal, providing for navigation at higher stages, may be necessary. It is the judgment of the Board that this part of the subject should be postponed until the interests of navigation demand its consideration, and in the mean time the project recommended should be completed as rapidly as possible, in order that the navigation of this portion of the river may be relieved at as early a day as practicable.

Respectfully submitted,

WM. P. CRAIGHILL,
Colonel, Engineers.
G. L. GILLESPIE,
Lieut. Col., Engineers.
JAS. C. POST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

S S 3.

IMPROVEMENT OF THE CHEHALIS RIVER, WASHINGTON TERRITORY.

The project for the improvement of this river consists in removing logs, snags, and other obstructions from its bed and banks, so as to provide a navigable channel-way during its medium and higher stages for steam-boats from Claquato, a town situated at its headwaters, to its mouth in Gray's Harbor. This distance is between 80 and 100 miles. Montesano, 12 miles from its mouth, is the head of coasting navigation. Eighteen feet at high tide can be carried to this point. The head

of tide is at Elma, about 16 miles above Montesano. Between these points navigation is obstructed by snags and fallen trees. By removing these a good all-the year-round channel can be provided from Elma to the mouth. Above Elma the river is practically blockaded during the summer and fall by snags, rafts, shoals, and principally a want of water. At this time the river-bed is a succession of shoals and pools; the depth of water on the shoals in many cases is reported to be from 6 to 12 inches. No attempt has yet been made to improve these shoals. With the funds appropriated for the improvement of this river, openings have been made through two large jams in the upper river, and the worst snags and drift-heaps removed from there to the head of coasting navigation. Logging and small-boat navigation have been facilitated by these operations. At the close of the last fiscal year a small party was in the field removing these obstructions. This party remained out until about the middle of August, when it was withdrawn and discharged because of an exhaustion of the funds available for the work. During July and August 353 snags and 129 overhanging trees were removed.

By virtue of paragraph 1, Special Orders, No. 60, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., March 14, 1888, I relieved Capt. Charles F. Powell, Corps of Engineers, of the charge of this work April 13, 1888.

The estimate for the fiscal year ending June 30, 1889, was $3,000. It was thought that this amount could be profitably expended on the river below Elma during that year. A like sum is estimated for work during the year ending June 30, 1890.

APPROPRIATIONS.

August 2, 1882	$3,000
July 5, 1884	2,500
August 5, 1886	2,500
Total	8,000

Chehalis River is in the collection district of Oregon. The nearest light-house is on Toke Point, at the entrance to Shoalwater Bay, 16 miles south of Gray's Harbor, into which the river empties.

Money statement.

July 1, 1887, amount available		$1,269.94
Received from sale of fuze and caps to appropriation improving Skagit and other rivers, Washington Territory		15.54
		1,285.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,244.97	
July 1, 1888, outstanding liabilities	1.34	
		1,246.31
July 1, 1888, balance available		39.17
Amount appropriated by act of August 11, 1888		2,000.00
Amount available for fiscal year ending June 30, 1889		2,039.17
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,000.00

SS 4.

IMPROVEMENT OF THE SKAGIT, STEILAQUAMISH, NOOTSACK, SNOHOMISH, AND SNOQUALMIE RIVERS, WASHINGTON TERRITORY.

The waters of these rivers all rise on the western slope of the Cascade Range and empty into Puget Sound, on its eastern side, between the forty-ninth and forty-eighth parallels.

The Snoqualmie is a branch of the Snohomish.

The aggregate lengths of all is estimated to be about 250 miles.

The project for their improvement contemplates the removal of logs, snags, trees, and other obstructions to their navigation. There is provided for this purpose a snag-boat, partially completed, with an outfit of tools and appliances, which passes from one river to the other, doing service in each as far as the necessities of the commerce require and the limited appropriations will admit. At the end of the last fiscal year $3,828.57 were available for operations upon these rivers and the care of the property.

By the 22d of August, the waters having run out to a fair working stage, the boat was set to work in the Snohomish and Snoqualmie rivers. These operations were continued until October 26, when the funds which could be devoted to the work became exhausted and the boat was laid up in ordinary. During these two months of active work 708 snags were removed from these rivers, resulting in a material improvement to their navigation. No work was done in either of the other rivers, and they remain in the same condition as reported in the last Annual Report.

The funds on hand are now substantially exhausted, being but $102.15, barely sufficient for the care of the property for two months. During the year but two months were devoted to active field work and about $2,200 spent. During ten months the plant was tied up to the bank and $1,000 spent in repairs and taking care of it. With the funds that may become available for operations during the coming fiscal year obstructions will be removed from these rivers in accordance with the project.

By virtue of paragraph 1, Special Orders, No. 60, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., March 14, 1888, I relieved Capt. Charles F. Powell, Corps of Engineers, of the charge of this work April 13, 1888.

APPROPRIATIONS.

June 14, 1880	$2,500
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	10,000
Total	42,500

These rivers are in the collection district of Puget Sound. The nearest port of entry is Port Townsend, Wash. The nearest light-houses are on Puget Sound.

Money statement.

July 1, 1887, amount available		$3,829.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,727.39	
July 1, 1888, outstanding liabilities	.82	
		3,728.21
July 1, 1888, balance available		101.33
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,101.33
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,000.00

S S 5.

GAUGING WATERS OF THE COLUMBIA RIVER, OREGON.

The object of these gaugings is to keep a record of the fluctuations of the Columbia River, which will be used in connection with its improvement at various points. By the gauges established at various points the pilots, captains, and those interested in navigation are enabled to ascertain the stage of water at all times on the crossings and places of difficult navigation, and to regulate the movement and draught of their vessels accordingly. An automatic self-registering gauge at Astoria has been found to be useful in indicating, in a general way, the condition of the bar at the mouth of the river, besides giving much data from which the tide tables are constructed.

It is unfortunate that these various gauge-readings could not be made continuous. Owing to a want of funds with which to pay the small but necessary expense of their maintenance and observation, they were discontinued.

To maintain them constantly a yearly appropriation of $2,000 will be necessary.

APPROPRIATIONS.

August 2, 1882	$500
July 5, 1884	1,000
August 5, 1886	1,000
Total	2,500

Money statement.

July 1, 1887, amount available	$45.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	45.20
Amount appropriated by act of August 11, 1888	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

S S 6.

PRELIMINARY EXAMINATION OF WOOD RIVER, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 14, 1887.

SIR: I have the honor to here submit a report of a preliminary examination of Wood River, Oregon. A report based on information obtained to that time was forwarded last February; the tenor of this report was that the river was not worthy of improvement. Since then further investigation and a personal examination have been made; and I have now to say that the river is not worthy of improvement, since it is not a navigable water of the United States and since it has no present commerce nor any prospective commerce of a value commensurate with the cost of improvement.

Wood River is a short stream flowing south from near Crater Lake, in the Cascade Mountains of southern Oregon, and emptying into Upper Klamath Lake at its northern end. The lake is some 30 miles long by 5 to 15 miles wide, and is quite navigable. Link River, not navigable, 1½ miles long, and at whose mouth is Linkville, forms the outlet of Upper Klamath Lake.

A small screw-steamer runs on the lake from near the head of Link River to near the foot of Wood River, these landings being naturally the lowest and highest points which a steam-boat can reach.

There is no business for a steamer on Wood River, except possibly some Government freighting, to cheapen which is the argument, as understood, of the citizens who desire the improvement.

The lower part of Wood River is the western boundary of the Klamath Indian Reservation; Fort Kalmath, a one-company infantry post, is 1.5 miles east of a wagon bridge crossing Wood River, about 6 miles from its mouth; the Indian agency is about 2 miles east of the river and nearly half-way from the upper lake landing to the fort.

Upon inquiry, the military department commander forwarded a report of the Fort Klamath post commander, stating that it is not likely if navigation by steamer on Wood River were made good that it could cheapen freight charges at Fort Klamath over the route now used. It appears, further, that these routes are apt to be improved in the near future by the construction of railroads in the adjacent country, and that Fort Klamath is not expected to be a permanent post. These remarks are applicable to the situation at the Indian agency.

Most of the Government supplies are delivered by wagon over the Klamath River road through Linkville, and thence over a good road to the east of Klamath Lake; it appears it would not pay to make two additional handlings of the freight to secure part water carriage, and which would replace the best part of the land haul.

A portion of the Government supplies, potatoes and flour, come from Linkville or from a mill between Linkville and the landing at the foot of the lake. These supplies go up the lake to the upper landing and thence by wagon over an excellent road, about 4 miles to the agency and 9 miles to the fort; the land freighters here are Indians, who are hired at low rates. Steamboating on Wood River would aid this freightage. The only way to attain it at reasonable cost is by means of a small light-draught stern-wheel boat of good power, instead of the two weak and deep boats heretofore used.

Wood River, even below the bridge crossing, is a narrow, rapid stream, meandering between low banks, and with a delta mouth having very shoal and intricate channels. Above the delta the depths are 2 to 3 feet, and sometimes 5 feet; the width is from 30 to 40 feet; the bed of the stream is in constant motion; it consists of light mountain detritus, slowly transported along in immense volume and through several mouths to the shoal part of the lake.

A strong, flat-bottomed stern-wheel boat could plow through the bottom or wash out a pathway, which of course would speedily fill up; but to maintain a channel by permanent works or by machines would be exceedingly difficult and expensive.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

S S 7.

PRELIMINARY EXAMINATION OF LINK RIVER, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 14, 1887.

SIR: I have the honor to here submit a report of a preliminary examination of Link River, Oregon. A report based on information obtained to that time was forwarded last February; the tenor of this report was that the river was not worthy of improvement. Since then further investigation and a personal examination have been made; and I have now to say that the river is not now worthy of improvement by the General Government, since it is doubtful if it be a navigable water of the United States, and since its present and prospective commerce are not of a value commensurate with the cost of an adequate improvement.

Link River is the outlet of Upper Klamath Lake, southern Oregon. The river is 1½ miles long, and has a fall, principally in its middle third, of some 60 feet. There is a low fixed county bridge at Linkville. This place is the county seat and local center of trade of the Klamath country, a sparsely settled grazing and farming region, and is situated at the foot of the river, and on the shore of a small lake not specially named, in which the waters spread out before forming Klamath River; this river sends an arm from near its head into the Lower Klamath Lake, which is partly in California.

There is a small screw-steamer on the Upper Klamath Lake, and a stern-wheel boat, it is understood, is now being placed to run from Linkville to the lower lake and on some 12 miles of the upper portion of Klamath River, or to a point where the new town of Keno, Oregon, has been founded, and where a wagon bridge crosses the river. There is good water for not more than a mile below the town; rapids then commence and continue along the river's course through northwestern California almost to the ocean, some 220 miles. On this part of the river there is no navigation, nor, as far as present information goes, any expectation of navigation.

The supplies for the Klamath country are hauled in by wagon from the California and Oregon Railroad, over the Klamath River road via Keno to Linkville. Wagons with Government freight for Fort Klamath and the Klamath Indian Agency go through Linkville and 28 miles further to the steamer landing on the upper lake, the nearest one to the post and agency. The full improvement of Link River would aid this Government transportation.

On the other hand, the Government establishments named are not at all likely to be permanent, and the building of railroads through or near the Klamath country, which may be expected soon, may change local transportation routes, so that Link River, even if improved, would have less influence than upon present transportation routes. A small boat railway is the plan of improvement adapted for the situation at Link River; but it is believed the whole yearly cost of the Government wagon freighting, which could be replaced by the water carriage, is less than the interest on the cost of the boat railway.

Improvement of Link River would be very convenient for the steamboat on the upper lake, since then she could land directly at Linkville, instead of approaching only within 1½ miles of the nearest business part of the town. The steamer's traffic is now entirely local. It is possible,

however, that commerce from California points on the lower lake to Linkville and to the upper lake may in the future form an interstate highway along this part of the Klamath water-way. Not much is known of the navigability of the lower lake; there has been no boating upon it as yet, and some parts are thought to be nothing more than extensive marsh.

The building of locks by the Government to overcome the 62-foot fall of Link River has been proposed, but most of the citizens whose opinion is known desire the removal of a low, narrow reef from the extreme head of the river. Below this reef, and before the main rapids commence, is a pool of slackwater, about half a mile long, and whose surface is 1½ feet to 2 feet below the lake surface. A safe channel through the reef would bring the steam-boat landing a half mile nearer the town; but the main result desired is the lowering of the lake, in order to drain tracts of swamp lands, which border the Upper Klamath, and connecting lakes. A complete removal of the reef, several hundred feet long, would be necessary for this work, which may be proper for the county or State to undertake or to authorize.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX T T.

IMPROVEMENT OF COLUMBIA AND WILLAMETTE RIVERS BELOW PORTLAND, OREGON, OF UPPER WILLAMETTE, UPPER COLUMBIA, AND SNAKE AND COWLITZ RIVERS, OREGON AND WASHINGTON TERRITORY, AND OF LOWER CLEARWATER RIVER, IDAHO.

REPORT OF MAJOR WILLIAM A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Columbia and Lower Willamette Rivers, below Portland, Oregon.
2. Upper Willamette River, Oregon.
3. Upper Columbia and Snake Rivers, Oregon and Washington Territory.
4. Lower Clearwater River, Idaho.
5. Cowlitz River, Washington Territory.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, July 3, 1888.

SIR: I have the honor to submit herewith annual reports for the works of river improvement temporarily in my charge on June 30, 1888.

These works were in charge of Maj. W. A. Jones, Corps of Engineers, until June 20, 1888, and the annual reports were prepared by him, and are forwarded by me without change or addition.

Very respectfully, your obedient servant,

W. YOUNG,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

As the commerce in all the region in which these works lie centers in Portland, Oregon, to avoid repetition I will submit herewith the commercial statistics sequired by Congress, making reference thereto in the description of each work.

The rivers are in the collection districts of Willamette and Oregon. The ports of entry are Portland and Astoria, Oregon. The nearest light-houses and works of defense are at the mouth of the Columbia River.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Portland, Oregon, during the year ending June 30, 1888.

Vessels—	Coastwise.		Foreign ports.				Totals.	
			American.		Foreign.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
Arrived in 1887-'88	126	172,626	4	3,214	105	129,278	235	305,118
Cleared in 1887-'88	132	188,775	21	21,824	97	116,977	250	327,576

Commerce, 1887-'88:

Exports	$4,619,015.00
Imports	864,665.97
Duties collected	550,821.35

Columbia River wheat fleets.

Years.	British.	American.	All others.	Total cleared.	Total tonnage.
1875-'76	48	9	2	59	60,556
1876-'77	53	9	7	69	57,157
1877-'78	62	10	4	76	74,429
1878-'79	49	13	1	63	65,301
1879-'80	67	8	6	81	73,359
1880-'81	71	15	3	89	79,038
1881-'82	102	16	5	123	117,281
1882-'83	55	19	6	80	82,601
1883-'84	74	18	2	94	98,687
1884-'85	91	19	4	114	113,639
1885-'86	126	11	4	141	153,306
1886-'87	121	10	1	132	142,397
1887-'88	92	5	4	101	125,501

Coal fleet arriving at Portland, Oregon, during the year ending June 30, 1888.

Months.	Domestic.		Foreign.		Totals.	
	Cargoes.	Tons.	Cargoes.	Tons.	Cargoes.	Tons.
July	1	2,200	3	1,014	4	3,214
August	4	2,550	9	4,500	13	7,050
September	3	2,218	2	1,450	5	3,668
October	4	2,858	5	4,818	9	7,676
November	6	3,500	9	9,200	15	12,700
December	3	4,200	5	3,500	8	7,700
January	1	1,185	2	1,262	3	2,447
February	5	6,754	3	3,623	8	10,377
March	2	2,800	10	11,400	12	14,200
April	2	1,838	4	3,650	6	5,488
May	2	2,400	3	3,400	5	5,800
June	2	2,550	1	2,055	3	4,605
Total	35	35,053	56	49,872	91	84,925

Arrivals and clearances of vessels and commerce at Astoria, Oregon, during the year ending June 30, 1888.

Vessels—	Coastwise.		Foreign ports.				Totals.	
			American.		Foreign.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
Arrived in 1887-'88	220	312,444	8	7,768	87	104,272	315	424,484
Cleared in 1887-'88	223	311,424	10	9,978	110	128,602	343	450,004

Commerce, 1887-'88:

Exports	$1,182,231.00
Imports	112,445.00
Duties collected	37,773.04

Statement of Cowlitz River traffic, furnished by Joseph Kellog & Co., owners of the Cowlitz River steamers.

Years.	General merchandise.	Hay.	Shingles.	Coal.	Lumber.	Logs.	Live-stock.	Passengers.
	Tons.	*Tons.*	*Bunches.*	*Tons.*	*Feet., B. M.*	*Feet., B. M.*		
1878	2,947	894	20,705	.....	776,120	(*)	3,020	8,439
1879	3,145	1,249	24,413	.....	1,196,281	(*)	4,178	9,240
1880	3,358	1,189	25,795	.....	1,257,500	(*)	5,725	10,472
1881	3,805	1,038	38,770	.....	1,358,640	(*)	5,502	11,155
1882†	10,285	(‡)	21,346	.....	1,658,000	13,000,000	5,364	11,632
1883	12,436	4,114	32,509	.....	1,498,083	(*)	5,586	21,227
1884	4,285	2,575	28,525	.....	850,094	12,000,000	3,312	12,000
1885	6,383	3,307	51,286	.....	1,802,517	(*)	4,317	12,835
1886	7,180	3,640	61,543	300	2,072,894	13,000,000	4,900	11,552
1887	7,898	4,110	67,594	.....	2,381,890	14,000,000	4,853	12,892
1888	7,480	2,508	121,446	10	1,089,338	32,000,000	4,772	11,688

* Figures not given.
† Amounts for 1882 include Columbia River traffic between Portland and mouth of Cowlitz River.
‡ Included in general merchandise.

LIST OF STEAMERS PLYING ON UPPER WILLAMETTE, LOWER WILLAMETTE, AND COLUMBIA, UPPER COLUMBIA, AND SNAKE RIVERS, OREGON AND WASHINGTON TERRITORY.

Name.	Tons.
Upper Willamette River:	
Salem	240
City of Salem	423
Calliope	93
Champion	502
Fleetwood	68
Latona	75
Little Annie	72
Mountaineer	47
Western Queen	75
Three Sisters	296
Wonder	225
Alliance	140
Pioneer	80
Bonanza	468
Occident	430
Orient	430
S. F. Church	394
Isabel	200
N. S. Bentley	401
P. W. W	59
Wasco	215
Total	4,933
Lower Willamette and Columbia Rivers:	
Governor Newell	134
General Canby	44
Joseph Kellogg	272
Lucea Mason	140
Lurline	338
Manzanilla	130
Multnomah	278
R. R. Thompson	912
S. G. Reed	607
Toledo	207
Traveler	145
Wide West	929
Tacoma	1,312
Alice	334
E. N. Cook	299
Ocklahama	394
Beda	269
Walla Walla	1,239
Alaskan	1,259
Fannie	276
Dewdrop	80
Lower Willamette and Columbia Rivers—Continued.	
Montesano	87
General Miles	68
Margey	98
Dolphin	60
Wallaski	65
Mischief	50
Nellie S. Chapman	150
Frolic	40
Maria	185
G. W. Elder	1,709
Willamette Chief	524
Oregon	1,642
State of California	1,260
Undine	280
A. B. Field	97
Telephone	443
Columbia	1,746
Clara Parker	195
Dixie Thompson	297
Hassalo	350
T. J. Potter	925
W. M. Hoag	431
Total	20,300
Middle and Upper Columbia Rivers:	
Fred Billings	383
Harvest Queen	697
Kootenai	268
Bonita	377
Total	1,725
Snake River:	
D. S. Baker	566
Almota	395
Mountain Queen	511
John Gates	550
Spokane	250
Annie Faxon	565
Total	2,837
Grand total	29,795

Statement of exports from Portland, Oregon, during the year ending June 30, 1888.

Articles.		Quantity.	Value.
Foreign.			
Wheat	bushels	5,312,528	$3,765,208
Flour	barrels	435,800	1,533,581
Salmon	pounds	6,016,800	684,916
Lumber	feet	12,221,000	145,620
Other articles			113,965
Total value			6,243,290
Domestic.			
Wheat	bushels	1,857,810	1,311,680
Flour	barrels	138,074	529,888
Salmon	pounds	17,534,460	1,753,446
Wool	do	7,439,872	1,165,420
Woolens	cases	939	179,550
Millstuffs	sacks	207,105	147,145
Flaxseed	do	48,121	136,455
Hides	pounds	1,736,894	132,235
Hops	do	1,889,842	163,748
Barrel stock	packages	15,228	23,997
Potatoes	bushels	191,564	141,165
Oats	do	585,712	172,725
Barley	do	27,615	12,620
Leather	pounds	128,339	23,101
Tallow	packages	548	3,018
Butter	do	848	14,485
Eggs	do	6,478	62,088
Provisions	do	10,320	151,903
Lumber	feet	74,768,000	858,886
Laths	number	11,271,000	22,732
Green fruit	boxes	54,180	39,973
Dried fruit	packages	2,934	16,150
Ore	sacks	27,242	83,966
Onions	bushels	20,122	14,557
Furs	pounds	29,184	25,370
Oil	barrels	120	1,050
Teasels	cases	49	49,000
Stoves	number	3,049	42,865
Merchandise, unspecified	pounds	5,300,000	124,000
Other articles			1,364,397
Total value			8,767,615
Foreign			6,243,290
Domestic			8,767,615
Total			15,010,905

Receipts of produce at Portland, Oregon, during the year ending June 30, 1888.

Articles.		Valley.*	Eastern.†	Total.
Wheat	pounds	55,350,400	490,919,800	546,270,200
Flour	do	57,380,700	51,943,200	109,323,900
Oats	do	18,202,600	1,229,400	19,432,000
Barley	do	416,200	4,445,900	4,862,100
Bran	do	2,412,500	2,451,300	4,863,800
Millstuffs	do	7,342,600	3,410,000	10,752,600
Potatoes	bushels	90,008	.....	90,008
Wool	pounds	306,689	9,440,449	9,747,138
Hides	do	761,127	1,272,336	2,033,463
Butter	packages	1,362	389	2,251
Eggs	cases	9,955	101	10,056
Fruit	boxes	69,125	124	69,249
Lime	barrels	22,476	.....	22,476
Flaxseed	sacks	.....	78,146	78,146
Hops	pounds	1,479,308	20,690	1,499,998

* Willamette Valley. † Country tributary to Upper Columbia and Snake rivers.

Statement of traffic through the Willamette locks during the year ending June 30, 1888.

escription.	Quantity.	Description.	Quantity.
Freight down .....pounds..	45, 605, 500	Passengers down .....number..	4, 919
Freight up.....do....	10, 658, 000	Passengers up.....do....	4, 375
Lumber down.....feet, B. M..	885, 390		

T T 1.

IMPROVEMENT OF COLUMBIA AND LOWER WILLAMETTE RIVERS BELOW PORTLAND, OREGON.

This project covers the Columbia River from its mouth to the Willamette, and this river as far up as the city of Portland, Oregon, the whole distance being 100 miles. It provides for a ship-channel of 20 feet at low water, to be effected by contraction works and shore protection at four bars between Portland and Columbia City ; by temporary improvement; by dredging at those bars during the construction of the permanent works; by temporary improvement at three bars below Columbia City, and by snagging operations. The mean tide at Portland, or a low-river stage, is about 2 feet; at Astoria it is 7½ feet. This project now keeps the river below Portland about equal in navigability with the Columbia River Bar, and enables the average ships of the world to come inland 100 miles toward the place where the export products are raised.

RIVER WORK.

Operations of river improvement have been practically suspended on account of the lack of appropriation. The property and floating plant have been cared for, and the latter kept afloat by daily pumping. Careful watch has been kept over the river constructions. From time to time a few snags have been taken out by the propeller *Lincoln*, which boat has been kept in running order, so that her steam-pumps could be used in an emergency in keeping the other boats and scows afloat. When in use she was manned by the watchmen at the boat moorings.

SAINT HELEN'S BAR.

The scouring effect upon the bar produced by the dike has been watched carefully by two surveys made in August and two in September. They developed the fact that extensive scouring was going on and that a good channel might reasonably be expected to result from the dike as constructed. In the latter part of September a 20-foot channel had opened across the bar, but it was narrow and very oblique to the current, which precluded its use except at slackwater. At this juncture the Board of Trade of Portland raised a fund of $3,500 for dredging a channel across the bar, and requested me to supervise the work. The funds being placed at my disposal, the steam-ship *Walla Walla*, was hired by me at a cost of $450 per day, the tow-boat *Cascades of the Columbia* and propeller *Lincoln* were placed in commission as tenders, and, taking immediate personal direction of the work, the dike channel was opened by propeller-dredging in 4.6 days. The cut made was 500 feet long by 200 feet wide and to a mean low-water depth of 20 feet. About 20,000 cubic yards of coarse material was moved.

Later on minor surveys were made of the dredged channel, showing continued improvement. Surveys were also made in August and September of the bars at Walker's Island, Martin's Island, and the mouth of the Willamette, developing the fact that the channels at these points were good for the present season of low water.

PORTLAND HARBOR.

The examinations and surveys made of the bar at Ross Island developed the fact that the bar would have to be improved by dredging and that no further work could be done until a sufficient appropriation should be made. During the month of October two dangerous rocks were discovered on the edge of the steam-boat channel, and these were removed by a blasting party, made up from the watchmen at the yard, using the propeller *Lincoln*. Sixty cubic yards of submerged rocks were removed.

SNAG-BOAT.

Under a contract made with John F. Steffen, of Portland, Oregon, October 22, 1887, work was commenced on the snag-boat in the month of December, 1887, and she was completed in June, 1888. The following is a description of her:

Dimensions.	Feet.	Dimensions.	Feet.
General dimensions:		House on upper deck:	
Length from stem to transom	133	Length over walls (64 feet 6 inches)	68.5
Length from stem over wheel-guard	152	Width	24
Width of beam	32	Height (7 feet 6 inches)	7.5
Depth of hold (54 inches)	4.5	Roof to project 5 feet forward, and 4 feet on the rear.	
Width over all	33	Pilot-house:	
Crown at midship (6 inches)	0.5	Length over walls	16
A frame:		Width	11
Height from deck over all	37	Height (7 feet 9 inches)	7.75
Width (at base)	14	Corners of upper deck-house and those of pilot-house rounded with 5-inch radius.	
House on main deck:			
Length over walls (64 feet 6 inches)	98.5		
Width	28		
Height under roof (9 feet 6 inches)	9.5		
Roof to project 3 feet forward.		Cost	$13,500

SALMON FISHERIES.

Under Senate resolution of January 27, 1887, referred to me by the Chief of Engineers, an examination into the whole subject of the salmon fisheries of the Columbia River was completed and a report submitted under date of December 21, 1887.

It is proposed with the sum recommended for appropriation to complete the project for permanent works over the whole tidal section; to complete the works proposed at Martin's Island; to complete the project for Portland Harbor; to do all necessary dredging for temporary improvement, and to make all necessary repairs for the maintenance of construction and plant.

APPROPRIATIONS.

Act June 23, 1866, Lower Willamette	$15,000
Act March 2, 1867	30,000
Act July 25, 1868 (allotted)	21,000
Act April 10, 1869 (allotted)	13,365
Act July 11, 1870	31,000
Act June 10, 1872	50,000
	$160,365

Act March 3, 1873, Lower Willamette and Columbia, from Portland to the sea	$20,000	
Act June 23, 1874	20,000	
Act March 3, 1875	20,000	
Act August 14, 1876	20,000	
Act June 18, 1878	30,000	
Act March 3, 1879	45,000	
		$155,000
Act June 14, 1880, Lower Willamette and Columbia, from Portland to the sea, including bar at the mouth of the Columbia	45,000	
Act March 3, 1881	45,000	
Act August 2, 1882	100,000	
		190,000
Act July 5, 1884, Columbia and Lower Willamette rivers, below Portland, Oregon		100,000
Act August 5, 1886		75,000
Total		680,365

For commercial statistics see letter of transmittal.

Money statement.

July 1, 1888, amount available		$24,604.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	*$15,576.79	
July 1, 1888, outstanding liabilities	127.67	
July 1, 1888, amount covered by existing contracts	7,185.00	
		22,889.46
July 1, 1888, balance available		1,714.59
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		101,714.59

Amount (estimated) required for completion of existing project and maintenance	325,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	325,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

T T 2.

IMPROVEMENT OF UPPER WILLAMETTE RIVER, OREGON.

The object of the improvement is to secure light-draught navigation as far up as Eugene City, Oregon, inclusive of 12 miles of tributaries, an aggregate distance of 184 miles.

The plan consists of snagging, bar scraping, wing-dam construction, and rock-blasting. The present project was adopted in 1878. Estimated cost was $80,000, exclusive of about $12,000 per year for maintenance. The total amount appropriated to date for this project, $84,000. Amount expended thereon to date, $83,998.27.

Owing to lack of appropriations no river work was done. Property and floating plant has been maintained and cared for.

It is proposed, with the appropriation asked for, to operate with the snag-boat and a construction party in removing snags, scraping bars,

*This amount includes settlements at Treasury United States with the Western Union Telegraph Company for telegrams, amounting to $11.46.

building wing-dams, and such other work as may be necessary in keeping open a channel during the extreme low-water season, thus:

Current operations for maintenance of channel	$12,000
Rock removal and wing-dams	7,000
Surveys	3,000
Total	22,000

APPROPRIATIONS.

Act March 3, 1871	$16,000
Act March 3, 1873	3,000
Act June 23, 1874	7,500
Act March 3, 1875	25,000
Act August 14, 1876	20,000
Act August 18, 1878	20,000
Act March 3, 1879	12,000
Act June 14, 1880	12,000
Act March 3, 1881	15,000
Act August 2, 1882	5,000
Act July 5, 1884	10,000
Act August 5, 1886	10,000
Total	155,500

For commercial statistics see letter of transmittal.

Money statement.

July 1, 1887, amount available		$2,910.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	*$2,563.36	
July 1, 1888, outstanding liabilities	344.14	
		2,907.50
July 1, 1888, balance available		3.23
Amount appropriated by act of August 11, 1888		29,000.00
Amount available for fiscal year ending June 30, 1889		29,003.23

T T 3.

IMPROVEMENT OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON TERRITORY.

The plan of this improvement consists in submerged-rock blasting and bar-scraping, to secure a low-water channel of 5½ feet in the Columbia as far as Ainsworth, and 4½ feet in the Snake as far as Lewiston. The original estimate of cost is $132,000. Total appropriation for this project, $121,000. Amount expended thereon to date, $121,000. The project covers the Columbia River from Celilo, Oregon, to the mouth of the Snake, at Ainsworth, Wash., and the Snake from this point to Lewiston, Idaho.

It is proposed to apply the appropriation asked for to submerged-rock blasting in the rapids, and the removal of cobble-stone bars between Riparia, Wash., and Lewiston, Idaho.

*This amount includes settlements at Treasury United States with the Western Union Telegraph Company for telegrams, amounting to $1.39.

APPROPRIATIONS.

per Columbia River:		
Act June 10, 1872	$50,000	
Act June 23, 1874	20,000	
Act March 3, 1885	35,000	
		$105,000
per Columbia and Snake rivers:		
Act August 14, 1876	15,000	
Act June 18, 1878	20,000	
Act March 3, 1879	20,000	
Act June 14, 1880	15,000	
Act March 3, 1881	15,000	
Act August 2, 1882	6,000	
Act July 5, 1884	20,000	
		111,000
per Columbia River, including Snake River:		
Act August 5, 1886		10,000
Total		226,000

For commercial statistics see letter of transmittal.

Money statement.

ıount appropriated by act of August 11, 1888	$10,000.00
ımount (estimated) required for completion of existing project	16,000.00
ımount that can be profitably expended in fiscal year ending June 30, 1890	16,000.00
ubmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

T T 4.

IMPROVEMENT OF LOWER CLEARWATER RIVER, IDAHO.

The plan here is to make a channel through rock-reefs and cobble-one bars over a distance of 40 miles above Lewiston, to secure a depth 4 feet at low water.

The original estimated cost is $34,424. Total appropriation to date, 5,000. Total expenditures, $15,000.

No appropriation. No work done.

It is proposed during the coming year to complete the project. This e will tap an exceedingly rich and productive country, and when the ıall cost of the improvement is considered, it seems advisable to com-ete it at once.

APPROPRIATIONS.

t March 3, 1879	$5,000
t June 14, 1880	5,000
t August 2, 1882	5,000
Total	15,000

For commercial statistics see letter of transmittal.

Money statement.

ımount (estimated) required for completion of existing project	$19,424.00
ımount that can be profitably expended in fiscal year ending June 30, 1890	19,424.00
ubmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

T T 5.

IMPROVEMENT OF COWLITZ RIVER, WASHINGTON TERRITORY.

The plan of improvement of this river consists in wing-dam construction, bar-scraping, and snagging operations, to secure a light-draught navigation up to Toledo, a little more than 30 miles above the mouth.

The original estimated cost of this work is $3,000 for the first year, and an annual expenditure thereafter of $2,000 for maintenance. The amount expended to the end of the fiscal year is $8,000.

The work of improvement on this river has made a commercial development very large in proportion to the amount expended, and I am of the opinion that operations should be extended to Klikitat Bridge, about 20 miles above Toledo, and also to include shore protection where necessary. The estimate submitted has this extension in view.

No appropriation. No work done.

It is proposed to apply the sum asked for to channel maintenance, wing-dam construction, and shore protection.

APPROPRIATIONS.

Act June 14, 1880	$2,000
Act March 3, 1881	1,000
Act August 2, 1882	1,000
Act July 5, 1884	2,000
Act August 5, 1886	2,000
Total	8,000

For commercial statistics see letter of transmittal.

Money statement.

Amount appropriated by act of August 11, 1888	$3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,000.00

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k in Mattaponi River, Va., removal of	116		845		
k in Chehaw River, S. C., removal of	138		991		
ks in Saint John's River, Fla., removal of	151		1122		
ks in Pensacola Harbor, Fla., removal of	158		1189		
Y.					
in River, N. C., examination of	134		948		
in River, N. C., improvement of	127		917		
usha River, Miss., improvement of			1362		
ina Bay, Oregon, improvement of entrance to	299			2146	
River, Miss., improvement of	181		1359		
wstone National Park, construction of roads and bridges in	314				2803
wstone River, Mont. and Dak., improvement of	206			1559	
Harbor, Me., improvement of	19	393			
River, Va., improvement of	113		830		